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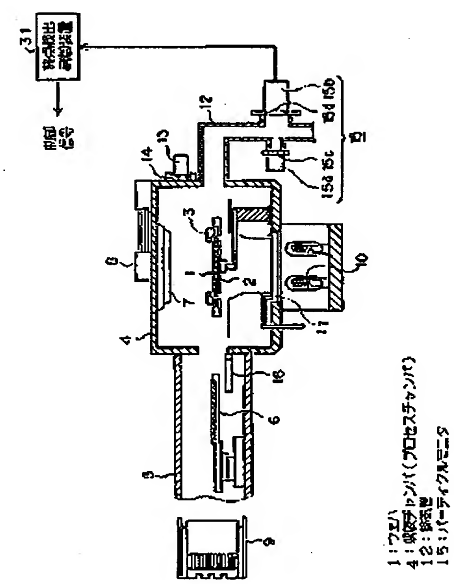
(54)【発明の名称】　半導体製造装置並びに発塵評価装置および発塵評価方法

(57)【要約】

【課題】　エンドポイント検出器を用いたプラズマエッチングや成膜装置のプラズマクリーニングにはエンドポイントの検出不良が生じるという課題があった。

【解決手段】　プロセスチャンバ4内のガスを排気する排気管12に設けたパーティクルモニタ15が微小粒子数を計測し、この計測値を終点検出制御装置31が時系列で観測してプラズマエッチングあるいはプラズマクリーニングの終点を検出するものである。



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【特許請求の範囲】

【請求項１】　内部に半導体ウェハを収納し、該半導体ウェハ上に堆積された薄膜をプラズマを用いてエッチングし、あるいは内部に付着した堆積物をプラズマを用いてクリーニングするプロセスチャンバと、該プロセスチャンバ内のガスを排気する排気管と、該排気管に設けられ、上記プラズマエッチング時またはプラズマクリーニング時に発生する粒子数を計測するパーティクルモニタと、該パーティクルモニタが計測する粒子数を時系列で観測して、上記プラズマエッチングまたはプラズマクリーニングの終点を検出し、上記プラズマエッチングまたはプラズマクリーニングを終了させる終点検出制御装置とを備えた半導体製造装置。

【請求項２】　プロセスチャンバとパーティクルモニタとの間の排気管に、上記プロセスチャンバと上記パーティクルモニタとの間を遮断する遮断弁を設けたことを特徴とする請求項１記載の半導体製造装置。

【請求項３】　遮断弁として、ゲート弁またはボール弁を用いたことを特徴とする請求項２記載の半導体製造装置。

【請求項４】　内部に半導体ウェハを収納し、該半導体ウェハ上に堆積された薄膜をプラズマを用いてエッチングし、あるいは内部に付着した堆積物をプラズマを用いてクリーニングするプロセスチャンバと、該プロセスチャンバ内のガスを排気する排気管と、該排気管に設けられ、上記プラズマエッチング時またはプラズマクリーニング時に発生する粒子数を計測するパーティクルモニタと、該パーティクルモニタが計測する粒子数を時系列で観測して、上記プラズマエッチングまたはプラズマクリーニングの終点を検出して、上記プラズマエッチングまたはプラズマクリーニングを終了させる終点検出制御装置とを備えた半導体製造装置であって、上記プロセスチャンバに複数の排気管を設け、各排気管にパーティクルモニタを設置し、上記複数のパーティクルモニタからの発塵時刻検出信号を基に発塵場所を算出する信号処理装置を備えた半導体製造装置。

【請求項５】　所定の粒径のブラスト材を用いて表面をブラスト処理した磁性を有する部材と、該部材を変形させて残留ブラスト材を放出させる部材変形手段とを備えた発塵評価装置。

【請求項６】　表面をブラスト処理した磁性を有する部材の材料にステンレスを用い、部材変形手段を磁性を有するステンレス板を片持ち梁状に支持する支持台と、ステンレス板の自由端を吸引・反発させる電磁石とで構成したことを特徴とする請求項５記載の発塵評価装置。

【請求項７】　請求項１から請求項４のうちのいずれか１項記載の半導体製造装置のプロセスチャンバ内に、請求項５または請求項６記載の発塵評価装置を少なくとも１台設置し、該発塵評価装置を真空中または所定のプロセスガス雰囲気中で動作させて多数の粒子を発生させ、パーティクルモニタによってこれらの粒子を検出することにより、粒子の飛行速度の較正を行うことを特徴とする発塵評価方法。

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【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は、半導体製造装置並びに発塵評価装置および発塵評価方法に関するものである。

【０００２】

【従来の技術】ＣＶＤ（Chemical Vapor Deposition）法で成膜したタングステン（Ｗ）は優れた段差被覆性を示すため、半導体集積回路装置の配線膜として利用されている。図８は例えば特開平６－１８８１９３号公報に示された従来のタングステンＣＶＤ装置を模式的に示す断面構成図である。図において、１はシリコンなどの半導体から成るウェハ、２はウェハ１を載置して支持するサセプタ、３はウェハ１をサセプタ２に密着させるとともに、成膜時にウェハ１外周部をマスキングして未成膜部を形成するためのシャドウリングである。４は成膜チャンバ、５は成膜チャンバ４と外部との間で真空を破らずにウェハ１の受け渡しを行うために設けられた予備室、６は成膜チャンバ４と外部との間でウェハ１の受け渡しを行うウェハ搬送ロボットアーム、７は成膜チャンバ４内にガスを導入する、表面に多数の孔が形成された多孔ノズルヘッド、８は多孔ノズルヘッド７までガスを供給するガス供給系、９は所定枚数のウェハ１を収納して運搬可能にしたウェハカセット、１０はサセプタ２を加熱するランプ、１１はランプ１０とサセプタ２との間の成膜チャンバ４の壁部に設けられたランプウインドウである。

【０００３】１２は成膜チャンバ４内のガスを装置外へ排気する排気管、１３はプラズマクリーニングのエンドポイント（終点）を検出するエンドポイント検出器、１４は成膜チャンバ４のエンドポイント検出器１３が装着される壁部に形成された窓、１５はパーティクルモニタであり、レーザ照射系１５ａ、検出器１５ｂ、および窓１５ｃ，１５ｄから構成されている。１６は成膜チャンバ４と予備室５との間の気密性を保つために設けられ、ウェハ１の搬出入時に開けられるスリットバルブである。３３はエンドポイント検出器１３が検出するプラズマクリーニングのエンドポイント検出信号に基づいてプラズマクリーニングの終了を制御する制御信号を出力する終点検出制御装置である。

【０００４】次に動作について説明する。ウェハカセット９を予備室５に装着し、予備室５を外気から遮断したのち、スリットバルブ１６を開いて予備室５と成膜チャンバ４とを同気圧にしたのち、ウェハ搬送ロボットアーム６を用いてウェハカセット９からウェハ１を１枚取り出しサセプタ２上に載置する。次いでサセプタ２を上昇させてシャドウリング３をウェハ１の外周部に被着させ

る。サセプタ2はランプ10の輻射熱により予め昇温されているから、サセプタ2上に載置されたウェハ1はサセプタ2からの熱伝導により速やかに所定の温度に到達する。この状態で多孔ノズルヘッド7から反応ガスをウェハ1表面に吹き付けてタングステン薄膜を形成する。反応ガスとしては例えばモノシラン（SiH_4）と6フッ化タングステン（WF_6）との混合ガスを用いる。ウェハ1表面に所定の膜厚のタングステン薄膜の成膜が終了したのち、ウェハ搬送ロボットアーム6を用いてウェハ1をサセプタ2から外して予備室5に戻すことにより一連の処理が終了する。

【0005】図8に示した従来のタングステンCVD装置では、ウェハ1以外にシャドウリング3やサセプタ2の側面および成膜チャンバ4の内壁など装置の構成部材のうち温度の高い部分の表面でもWF_6ガスが熱分解してタングステン膜が付着する。このタングステン膜を除去するために通常、プラズマクリーニングを行っている。プラズマクリーニングは、ウェハ1を1枚処理した直後に成膜チャンバ4内にNF_3ガスを導入してプラズマを発生させ、このプラズマにより装置の構成部材に付着したタングステン膜をエッチングして除去するものである。具体的には、多孔ノズルヘッド7を通して成膜チャンバ4内にNF_3ガスを導入し、多孔ノズルヘッド7とサセプタ2との間に高周波電圧を印加してプラズマを発生させる。このプラズマ放電によりNF_3ガスが分解されてFラジカル（活性種）が形成され、このFラジカルがタングステンと反応して揮発性のタングステンフッ化物を生成することによりタングステン膜をエッチングする。生成されたタングステンフッ化物は排気管12を通って成膜チャンバ4外へ排出される。

【0006】また図8に示したタングステンCVD装置では、プロセス条件の変動に起因してプロセスガスが予定外の気相成長を起こして微小粒子が発生したり、プラズマクリーニング不良に起因してタングステン膜のはがれが発生するなどして装置内に微小粒子が発生したりする。これらの微小粒子がウェハ1に付着すると製造中の集積回路装置に動作異常を発生させ、歩留まり低下の原因になる。装置内での微小粒子の発生を速やかに検知して製品不良の発生を最小限に止めるために、パーティクルモニタ15が用いられている。パーティクルモニタ15はプロセスガスの流れに乗って排気管12内を通過する微小粒子を検出できるので、装置内で微小粒子が発生したことを知ることができる。パーティクルモニタ15が微小粒子を検出し、それにより装置内での発塵が発見された場合には、直ちに製品処理を中止し、成膜チャンバ4を大気開放して内部をウェットクリーニングして装置内の発塵源を除去する。

【0007】

【発明が解決しようとする課題】従来の半導体製造装置は以上のように構成されているので、プラズマクリーニングの終点検出をエンドポイント検出器13を用いてプラズマ中のFラジカルの発光の変化を検出することにより行っていたが、ウェハ1の処理枚数が増えるとエンドポイント検出器13の窓14に堆積するタングステンの膜厚が増大するなどして窓14が曇り、プラズマからの発光が十分にエンドポイント検出器13に入射しなくなるため、エンドポイントの検出不良が生じるという課題があった。

【0008】また、パーティクルモニタ15に関しては、ウェハ1の処理枚数が増えると、窓15c、15dに堆積するタングステンの膜厚が増大するなどして窓が曇り、レーザ照射系15aから排気管12内を通過する微小粒子に照射されるレーザ光強度が低下する、あるいは微小粒子からの散乱光の検出率が低下するという課題があった。

【0009】さらに、従来の装置では微小粒子の検出精度を高めるためにパーティクルモニタ15はできるだけ成膜チャンバ4に近付けて設置しているので、パーティクルモニタ15の窓15c、15dが曇った場合、装置の運転を停止して成膜チャンバ4を大気開放してクリーニングしなければならない。したがってクリーニング中は成膜処理ができないので、装置の稼働率が低下するという課題があった。

【0010】さらに、パーティクルモニタ15は装置内で発塵があったことを検知するだけで、発塵個所を特定するのは困難であった。具体的には、装置内のどの部分で発塵が発生したかという情報を得ることができないため、例えばウェハ1の搬送路の位置ずれが発生している場合でもその位置ずれの方向を特定できないので、対策を講じられないという課題があった。

【0011】さらに、パーティクルモニタ15の検出精度の較正は通常、大気圧状態において標準粒子発生源を用いて行っているため、パーティクルモニタ15を実際に使用する真空中あるいは低圧のプロセスガス中とは屈折率などが異なるから、実使用条件でのパーティクルモニタ15の検出精度の較正ができないという課題があった。

【0012】この発明は上記のような課題を解決するためになされたもので、エッチングやプラズマクリーニングのエンドポイント検出が長期間にわたり安定して可能な半導体製造装置並びに発塵評価装置および発塵評価方法を得ることを目的とする。

【0013】

【課題を解決するための手段】請求項1記載の発明に係る半導体製造装置は、プロセスチャンバを備え、その内部に半導体ウェハを収納し、この半導体ウェハ上に堆積された薄膜をプラズマを用いてエッチングするエッチング装置、あるいは半導体ウェハ上に薄膜を堆積させる成膜装置である。エッチング装置の場合にはプラズマエッチングプロセスが対象となり、成膜装置の場合にはプロ

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セスチャンバの内部に付着した堆積物をプラズマを用いてクリーニングするプラズマクリーニングが対象となる。この発明では、プロセスチャンバ内のガスを排気する排気管に設けたパーティクルモニタがプラズマエッチング時またはプラズマクリーニング時に発生する粒子数を計測し、この計測値を終点検出制御装置によって時系列で観測してプラズマエッチングまたはプラズマクリーニングの終点を検出し、プラズマエッチングまたはプラズマクリーニングを終了させるものである。

【0014】請求項2記載の発明に係る半導体製造装置は、プロセスチャンバとパーティクルモニタとの間の排気管に、これらプロセスチャンバとパーティクルモニタとの間を遮断する遮断弁を設けたものである。

【0015】請求項3記載の発明に係る半導体製造装置は、遮断弁として、ゲート弁またはボール弁を用いたものである。

【0016】請求項4記載の発明に係る半導体製造装置は、その基本構成を請求項1記載の半導体製造装置と共通にするものであり、プロセスチャンバに複数の排気管を設け、各排気管にパーティクルモニタを設置し、この複数のパーティクルモニタからの発塵時刻検出信号を基に発塵場所を算出する信号処理装置を備えたものである。

【0017】請求項5記載の発明に係る発塵評価装置は、所定の粒径のブラスト材を用いて表面をブラスト処理した磁性を有する部材と、この部材を変形させて残留ブラスト材を放出させる部材変形手段とを備えたものである。

【0018】請求項6記載の発明に係る発塵評価装置は、表面をブラスト処理した磁性を有する部材の材料にステンレスを用い、部材変形手段を磁性を有するステンレス板を片持ち梁状に支持する支持台と、ステンレス板の自由端を吸引・反発させる電磁石とで構成するものである。

【0019】請求項7記載の発明に係る発塵評価方法は、請求項1から請求項4のうちのいずれか1項記載の発明に係る半導体製造装置のプロセスチャンバ内に、請求項5または請求項6記載の発明に係る発塵評価装置を少なくとも1台設置し、この発塵評価装置を真空中または所定のプロセスガス雰囲気中で動作させて多数の粒子を発生させ、パーティクルモニタによってこれらの粒子を検出することにより、粒子の飛行速度の較正を行うものである。

【0020】

【発明の実施の形態】以下、この発明の実施の一形態を説明する。

実施の形態1．図1はこの発明の実施の形態1による半導体製造装置を示す図であり、この発明をCVD装置に適用した例を示す。図において、1はシリコンなどの半導体から成るウェハ、2はウェハ1を載置して支持するサセプタ、3はウェハ1をサセプタ2に密着させるとともに、成膜時にウェハ1の外周部をマスキングして未成膜部を形成するためのシャドウリングである。4は成膜チャンバ（プロセスチャンバ）、5は成膜チャンバ4と外部との間で真空を破らずにウェハ1の受け渡しを行うために設けられた予備室、6は成膜チャンバ4と外部との間でウェハ1の受け渡しを行うウェハ搬送ロボットアーム、7は成膜チャンバ4内にガスを導入する、表面に多数の孔が形成された多孔ノズルヘッドであり、反応ガスをウェハ1の全面に吹き付ける。

【0021】8はガス供給源（図示せず）から多孔ノズルヘッド7までガスを供給するガス供給系、9は所定枚数のウェハ1を収納して運搬可能にするウェハカセット、10はサセプタ2を加熱するためのランプ、11はランプ10とサセプタ2との間の成膜チャンバ4の壁部に設けられたランプウインドウ、12は成膜チャンバ4内のガスを装置外へ排気する排気管、13は成膜の終了時点を検出するエンドポイント検出器、14はエンドポイント検出器13が装着される成膜チャンバ4の壁部に形成された窓、15はパーティクルモニタであり、レーザ照射系15a、検出器15b、および窓15c、15dから構成されている。16は成膜チャンバ4と予備室5との間の気密性を保つために設けられ、ウェハ1の搬出入時に開けられるスリットバルブである。31はパーティクルモニタ15が出力する微小粒子カウント数信号を入力し、プラズマクリーニングのエンドポイントを検出するとともに、検出結果に基づいて装置各部に制御信号を出力する終点検出制御装置である。

【0022】次に動作について説明する。まずウェハカセット9を予備室5に装着し、予備室5を外気から遮断したのち、スリットバルブ16を開いて予備室5と成膜チャンバ4とを同気圧にする。成膜チャンバ4内は図示しない真空排気装置、例えばメカニカルブースターポンプを用いて10mTorr（およそ1Pa）程度の圧力まで排気されている。次いでウェハ搬送ロボットアーム6を用いてウェハカセット9からウェハ1を1枚取り出しサセプタ2上に載置したのち、サセプタ2を上昇させてシャドウリング3をウェハ1の外周部に密着させる。サセプタ2はランプ10の輻射熱により予め昇温されているから、サセプタ2上に載置されたウェハ1はサセプタ2からの熱伝導により速やかに所定の温度（400°Cないし500°C）に到達する。この状態で多孔ノズルヘッド7から反応ガスをウェハ1表面に吹き付けてタングステン薄膜を堆積する。

【0023】タングステン成膜プロセスの具体例をウェハ1上に形成されたコンタクトホールをタングステン（W）で穴埋めする例を用いて説明する。まずウェハ1上にタングステン（W）の核を形成するためにモノシラン（SiH_4）ガスと6フッ化タングステン（WF_6）ガスとを1：3の比率で混合したガスをキャリアガスに

アルゴン（Ａｒ）を用いてウェハ１上に３０秒間ないし１００秒間供給する。次にステップカバレージ（段差被覆性）の良い条件のガス，例えば６フッ化タングステン（WF_6）ガスと水素（H_2）とを１：５の割合で混合したガスをウェハ１上に５０秒間ないし２００秒間供給する。このプロセスにより穴埋め性の良好なタングステン膜が０．５～１．０μｍ程度の膜厚に堆積される。成膜終了後、ウェハ搬送ロボットアーム６を用いてウェハ１をサセプタ２から外して予備室５に戻す。以上で一連のタングステン（Ｗ）成膜プロセスが終了する。

【００２４】上述したこの実施の形態１に係るタングステンＣＶＤ装置でも従来の装置と同様に、ウェハ１表面以外にシャドウリング３の表面、サセプタ２の側面および成膜チャンバ４の内壁など装置の構成部材のうち温度の高い部分の表面でもWF_6ガスが熱分解するため、そこにタングステン膜が堆積する。これらの部材にタングステン膜が堆積していると次のタングステン成膜プロセスの遂行に不都合であるから、除去する必要がある。そのために通常，プラズマクリーニングを行う。

【００２５】プラズマクリーニングは，ウェハ１を１枚処理した直後に成膜チャンバ４内に３フッ化窒素（NF_3）ガスを導入してプラズマを発生させ、このプラズマにより装置の構成部材表面に堆積したタングステン膜をエッチングして除去するものである。具体的には多孔ノズルヘッド７を通して成膜チャンバ４内にNF_3ガスを導入し、多孔ノズルヘッド７とサセプタ２との間に高周波電圧を印加してプラズマを発生させる。このプラズマ放電によりNF_3ガスが分解されてＦラジカル（活性種）が形成され，このＦラジカルがタングステンと反応して揮発性のタングステンフッ化物を生成することによりタングステン膜をエッチングする。生成されたタングステンフッ化物は排気管１２を通って成膜チャンバ４外へ排出される。

【００２６】この実施の形態１では，プラズマクリーニングのエンドポイントの検出は、パーティクルモニタ１５がカウントする微小粒子のカウント値を終点検出制御装置３１が時系列的に観測することにより行う。図２はプラズマクリーニング時にパーティクルモニタ１５を用いて測定した微小粒子のカウント数の観測例を示すグラフ図である。図において，横軸はタングステンの発塵が観測された時点を始点とする経過時間（秒単位），縦軸はパーティクルモニタ１５における微小粒子カウント数（任意単位）である。図２から分かるようにプラズマクリーニング初期で成膜チャンバ４の内壁や構成部材にタングステン膜が残留している間は、揮発性のタングステンフッ化物とともにタングステンの微小粒子が発生するので，タングステンの発塵が観測される。タングステンの発塵量はプラズマクリーニングの開始直後から増大し，ある時間経過後にピークを付けたのち減少に転じ、ある時点で全く観測されなくなる。これは成膜チャンバ４の内壁などに堆積したタングステン膜が完全に除去されるとタングステン微小粒子の発生（タングステンの発塵）がなくなるためである。

【００２７】さらにプラズマクリーニングを続けると成膜チャンバ４の構成材料，例えばアルミナセラミックスの微小粒子が発生する（アルミナの発塵）。この実施の形態１では，終点検出制御装置３１がパーティクルモニタ１５によりカウントされたプラズマクリーニング中の発塵量の時間変化を観測し，最初の発塵がなくなった時点（図１の例では発塵開始から３０秒間経過後），すなわちタングステンの微小粒子の発生（タングステンの発塵）がなくなった時点をエンドポイントとして判定する。エンドポイントが判定されたら，終点検出制御装置３１は制御信号を出力してプラズマクリーニングを終了させる。

【００２８】この実施の形態１ではプラズマクリーニングのエンドポイントの検出にパーティクルモニタ１５が計測する微小粒子のカウント数を用いている。これにより次の利点が得られる。すなわちパーティクルモニタ１５はサセプタ２などの発熱部から離れた場所に位置する排気管１２に取り付けられているから，温度上昇が小さく，窓１５ｃ，１５ｄが曇りにくい。その結果パーティクルモニタ１５は常に正常に動作するので、プラズマクリーニングのエンドポイントを正確に検出できる。したがって長期間にわたって安定してプラズマクリーニングのエンドポイントの検出が可能となり，装置のメンテナンス周期を長くすることができるとともに、装置の稼働率を高めることができる。

【００２９】なお上述した実施の形態１では、この発明をタングステンＣＶＤ装置におけるプラズマクリーニングに適用した例を示したが，これに限らず、この発明はプラズマを発生させてエッチングやクリーニングを行うプロセス装置全般に適用することができる。例えば，シリコン酸化膜，シリコン窒化膜，ポリシリコン膜，タングステンシリサイド膜、アルミニウム膜，およびタングステン膜の成膜装置やこれらの膜のプラズマエッチング装置に適用することができる。

【００３０】実施の形態２．図３はこの発明の実施の形態２による半導体製造装置を示す図であり、この発明をＣＶＤ装置に適用した他の例を示す。図において，ウェハ１，サセプタ２、シャドウリング３，成膜チャンバ４，予備室５，ウェハ搬送ロボットアーム６、多孔ノズルヘッド７、ガス供給系８，ウェハカセット９，ランプ１０，ランプウインドウ１１、排気管１２、エンドポイント検出器１３，窓１４，パーティクルモニタ１５、レーザ照射系１５ａ、検出器１５ｂ、窓１５ｃ，１５ｄ、スリットバルブ１６、および終点検出制御装置３１は図１に示した上記実施の形態１の装置と同じものであるので，その説明を割愛する。

【００３１】この実施の形態２に係るタングステンＣＶ

D装置は図1に示した装置に加えて、排気管12に遮断弁17を設けたものである。この遮断弁17は成膜チャンバ4とパーティクルモニタ15との間に設けられ、成膜チャンバ4とパーティクルモニタ15とを真空分離するように作用する。遮断弁17としては、成膜チャンバ4から排気管12内を飛行する微小粒子の通行を妨げない構造の弁が望ましいので、例えばゲート弁やボール弁を用いる。

【0032】次に動作について説明する。パーティクルモニタ15の窓15c，15dは曇りにくいものであるが、装置を最適な状態に保つためにはこれらの窓15c，15dを定期的にクリーニングする必要がある。パーティクルモニタ15の窓15c，15dのクリーニングは、遮断弁17を閉じることにより成膜チャンバ4とパーティクルモニタ15とを分離して成膜チャンバ4を真空に保った状態で行う。これにより成膜チャンバ4内は大気にさらされないから、パーティクルモニタ15の窓15c，15dのクリーニングが終了したのち、遮断弁17を再開してタングステンの成膜処理を速やかに続行することができる。また、成膜チャンバ4を大気開放してメンテナンスを施す際に、パーティクルモニタ15の窓15c，15dの汚れが少ない場合は、遮断弁17を閉じて、パーティクルモニタ15を真空排気しておく。この操作により、窓15c，15dの付着物の酸化を抑制できるから、成膜チャンバ4のメンテナンス時に、パーティクルモニタ15の窓15c，15dをクリーニングしなくて済む。

【0033】以上のように、この実施の形態2によれば、成膜チャンバ4とパーティクルモニタ15との間に遮断弁17を設けたので、パーティクルモニタ15のメンテナンス中においても成膜チャンバ4内を真空に保つことが可能になる。その結果メンテナンス終了後の装置の立ち上げを即座に行うことが可能になるので、パーティクルモニタ15のメンテナンスに伴う装置の稼働率の低下を最小限に止めることができる。また装置のクリーニング頻度を低くすることができるので、装置の稼働率を高めることができる。

【0034】実施の形態3．図4はこの発明の実施の形態3によるCVD装置の主要部の破断斜視図であり、図において、1はウェハ、2はサセプタ、3はシャドウリング、4は成膜チャンバ、6はウェハ搬送ロボットアーム、11はランプウインドウ、12a、12bは排気管、15，18はパーティクルモニタであるが、これらの部品は図1に示した上記実施の形態1に係る装置のものと同じであるので詳細な説明は割愛する。

【0035】この実施の形態3に係るCVD装置は、成膜チャンバ4に複数の排気管12a、12bを設け、各排気管12a、12bにパーティクルモニタ15、18を設けたものである。図4は成膜チャンバ4に2個の排気管12a，12bを設け、各排気管12a，12bにパーティクルモニタ15、18を設けた例を示している。さらに、この実施の形態3に係るCVD装置は、パーティクルモニタ15，18が微小粒子数をカウントした値を出力する発塵信号を処理して成膜チャンバ4内の発塵が発生した位置を算出する信号処理装置21を備えている。

【0036】次に動作について説明する。ウェハ搬送ロボットアーム6を用いてウェハ1をサセプタ2上に載置する際に位置ずれが生じると、その後サセプタ2を上昇させてウェハ1にシャドウリング3を被着するときにウェハ1とシャドウリング3とがこすれて発塵する。これにより発生する微小粒子はプロセスガスの流れに乗って排気される。プロセスガスの流速は一定であるから、上述した微小粒子の飛行速度をvとすると、vはほぼ一定とみなせる。サセプタ2の上昇時にウェハ1とシャドウリング3とがこすれて発生する微小粒子が2個のパーティクルモニタ15，18まで飛行する時間t_1およびt_2は、図5に示すようにサセプタ2の上昇時刻を基準にして求めることができる。

【0037】図5に示すパーティクルモニタ15の検出信号（a）およびパーティクルモニタ18の検出信号（b）は信号処理装置21に出力される。検出信号（a）および（b）が入力された信号処理装置21は、図6に示すようにパーティクルモニタ15の設置位置を中心とし半径$t_1 v$の円C_{11}と、パーティクルモニタ18の設置位置を中心とし半径$t_2 v$の円C_{12}との交点Kを算出することにより発塵発生場所を特定する。発塵が発生する場所Kが特定されると、装置の制御部（図示せず）はウェハ1とシャドウリング3とのこすれを解消して発塵しないように、ウェハ搬送ロボットアーム6がウェハ1の受け渡しを行う位置の補正を行う。上述した一連の発塵解消操作は成膜チャンバ4の真空を破らずに行うことができるから、装置の稼働率を向上させることができる。

【0038】以上のように、この実施の形態3によれば、複数のパーティクルモニタ15、18と信号処理装置21とを用いて、ウェハ1受け渡し時に突発的なこすれ発塵が発生した場合、各パーティクルモニタ15，18が検出する発塵検出時間の違いから発塵場所を特定し、それに基づいてウェハ1の受け渡しに伴うこすれを、成膜チャンバ4の真空を破らずに解消できるようにしたので、装置の稼働率を大幅に向上することができる。

【0039】実施の形態4．図7はこの発明の実施の形態4による発塵評価装置を示す図であり、図において、100はこの発明に係る発塵評価装置、101はブラスト材を用いてブラスト処理を施した磁性を有するステンレス板（磁性を有する部材）、102は磁性を有するステンレス板101を片持ち梁状に支持する支持台（部材変形手段）、103は電磁石（部材変形手段）、104

は永久磁石、105は残留ブラスト材、106はステンレス粉末である。この実施の形態4に係る発塵評価装置はパーティクルモニタの検出精度の較正を行う際に、パーティクルモニタ15が検出する微小粒子の発生源として用いられる。

【0040】次に動作について説明する。図7に示すこの発明に係る発塵評価装置100に設けられた電磁石103に電源（図示せず）から断続的に電流を流すと断続的に磁力が発生する。この磁力により片持ち梁状に支持された磁性を有するステンレス板101の自由端を吸引・反発させて変形させると、磁性を有するステンレス板101の表面から残留ブラスト材105が放出される。この残留ブラスト材105の粒径はブラスト処理に用いるブラスト材の粒径で規定される。残留ブラスト材105としては粒径が、概ね1μmから20μmの範囲内にあるものを用いる。したがって磁性を有するステンレス板101の表面から放出される残留ブラスト材105の粒径は概ね1μmから20μmの範囲内の値でほぼ均一なものとなる。一方、同時に放出されるステンレス粉末106は粒径に均一性がないので、永久磁石104に吸着させることにより除去している。

【0041】図7に示すこの発明に係る発塵評価装置100を、例えば図1に示す実施の形態1に係る半導体製造装置の成膜チャンバ4内に設置し、規定周波数のパルス電流を電磁石103に印加すると磁性を有するステンレス板101表面から粒径が均一な残留ブラスト材105が単位時間内に規定個数放出される。これらの残留ブラスト材105が排気管12内を通って装置外へ排出されるときにパーティクルモニタ15を通過するから、パーティクルモニタ15は単位時間内に通過する残留ブラスト材105の個数をカウントする。そのカウント値が規定範囲内に納まるように感度を調整することによりパーティクルモニタ15の検出精度を較正する。

【0042】以上のように、この実施の形態4によれば、真空中あるいは低圧のプロセスガス中で動作可能であるから、実際の使用環境下で、かつ任意のタイミングで所定の粒径の粒子を発生させることができるので、パーティクルモニタ15の検出精度の較正を高い精度で行うことが可能になる。

【0043】なお、上記実施の形態4では腐食防止、プロセスガスに対する耐食性などの観点からブラスト処理を施す部材としてステンレスを用いた例を示したが、耐食性の高い他の磁性材料、例えばフェライトなどを用いても同様の効果がある。

【0044】実施の形態5．上記実施の形態3では微小粒子の飛行速度vをプロセスガスの流速と同等として構成したが、成膜チャンバ4の形状や微小粒子の粒径によっては、微小粒子の飛行速度vとプロセスガスの流速とが異なる場合も生じる。この場合には複数のパーティクルモニタ15を成膜チャンバ4に取り付けた半導体製造装置において、図7に示したこの発明に係る発塵評価装置100をこすれ発塵が発生しやすい場所、例えばシャドウリング3の内周上に対応する位置に設置してパルス的に動作させ、発生粒子を複数のパーティクルモニタ15で観測することにより微小粒子の飛行速度vを補正する。これにより突発的に発生する発塵の発生位置を特定する精度を向上させることができる。

【0045】

【発明の効果】請求項1記載の発明によれば、エッチング装置におけるプラズマエッチング、あるいは成膜装置におけるプラズマクリーニングの終点を、プロセスチャンバ内のガスを排気する排気管に設けたパーティクルモニタがプラズマエッチング時またはプラズマクリーニング時に発生する粒子数を計測し、この計測値を終点検出制御装置によって時系列で観測して検出するように構成したので、長期間にわたって安定してプラズマクリーニングのエンドポイントを検出することが可能となり、装置のメンテナンス周期を長くすることができるとともに、装置の稼働率を高める効果がある。

【0046】請求項2記載の発明によれば、プロセスチャンバとパーティクルモニタとの間の排気管に、これらプロセスチャンバとパーティクルモニタとの間を遮断する遮断弁を設けるように構成したので、パーティクルモニタのメンテナンス中においてもプロセスチャンバ内を真空に保つことが可能になる。その結果メンテナンス終了後の装置の立ち上げを即座に行うことが可能になるので、パーティクルモニタのメンテナンスに伴う装置の稼働率の低下を最小限に止めることができる効果がある。

【0047】請求項3記載の発明によれば、遮断弁として、ゲート弁またはボール弁を用いるように構成したので、プロセスチャンバからの微小粒子の飛行を妨げない効果がある。

【0048】請求項4記載の発明によれば、プロセスチャンバに複数の排気管を設け、各排気管にパーティクルモニタを設置し、この複数のパーティクルモニタからの発塵時刻検出信号を基に発塵場所を算出する信号処理装置を備えるように構成したので、ウェハ受け渡し時に突発的なこすれ発塵が発生した場合、複数のパーティクルモニタが検出する発塵検出時間の違いから発塵場所を特定するように構成したので、発塵場所の特定結果に基づいてウェハ受け渡しに伴うこすれを、プロセスチャンバの真空を破らずに解消できるため、装置の稼働率が大幅に向上する効果がある。

【0049】請求項5記載の発明によれば、所定の粒径のブラスト材を用いて表面をブラスト処理した磁性を有する部材と、この部材を変形させて残留ブラスト材を放出させる部材変形手段とを備えるように構成したので、この発塵評価装置は真空中あるいは低圧のプロセスガス中で動作可能であるから、実使用環境下で、かつ任意のタイミングで所定の粒径の粒子を発生させることができ

る。したがってパーティクルモニタの検出精度の較正を高い精度で行うことができる効果がある。

【0050】請求項6記載の発明によれば、表面をブラスト処理した磁性を有する部材の材料にステンレスを用い、部材変形手段を磁性を有するステンレス板を片持ち梁状に支持する支持台と、ステンレス板の自由端を吸引・反発させる電磁石とを備えるように構成したので、実用性の高い発塵評価装置を簡易な構成で実現できる効果がある。

【0051】請求項7記載の発明によれば、請求項1から請求項4のうちのいずれか1項記載の発明に係る半導体製造装置のプロセスチャンバ内に、請求項5または請求項6記載の発明に係る発塵評価装置を少なくとも1台設置し、この発塵評価装置を真空中または所定のプロセスガス雰囲気中で動作させて多数の粒子を発生させ、パーティクルモニタによってこれらの粒子を検出することにより、粒子の飛行速度の較正を行うように構成したので、微小粒子の飛行速度とプロセスガスの流速とが異なる場合、発塵評価装置をこすれ発塵が発生しやすい場所に対応する位置に設置してパルス的に動作させて発生する粒子を複数のパーティクルモニタで観測することにより微小粒子の飛行速度を補正することができるから、突発的に発生する発塵の発生位置を特定する精度を向上させる効果がある。

【図面の簡単な説明】

【図1】　この発明の実施の形態1による半導体製造装置を示す図であり、この発明をCVD装置に適用した例*を示す。

【図2】　プラズマクリーニング時にパーティクルモニタ15を用いて測定した微小粒子のカウント数の観測例を示すグラフ図である。

【図3】　この発明の実施の形態2による半導体製造装置示す図であり、この発明をCVD装置に適用した他の例を示す。

【図4】　この発明の実施の形態3によるCVD装置の主要部の破断斜視図である。

【図5】　パーティクルモニタ15の検出信号（a）およびパーティクルモニタ18の検出信号（b）を示す図である。

【図6】　パーティクルモニタ15の設置位置を中心とし半径 t_1 vの円 C_{15} と、パーティクルモニタ18の設置位置を中心とし半径 t_2 vの円 C_{18} との交点Kを算出する例を示す図である。

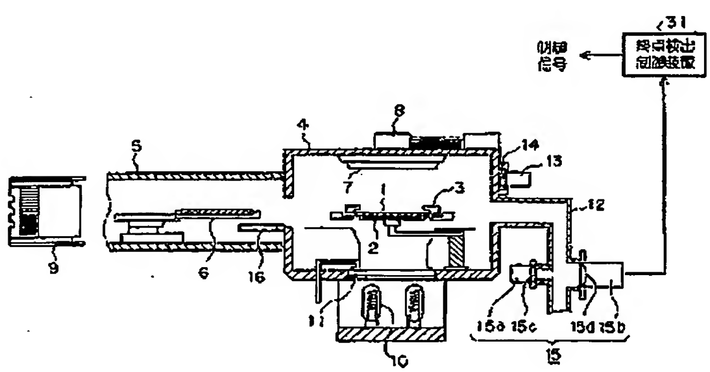
【図7】　この発明の実施の形態4による発塵評価装置の構造を示す図である。

【図8】　従来のタングステンCVD装置を模式的に示す断面構成図である。

【符号の説明】

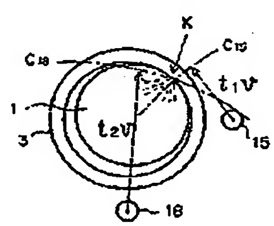
1　ウェハ、4　成膜チャンバ（プロセスチャンバ）、12　排気管、15パーティクルモニタ、17　遮断弁、21　信号処理装置、31　終点検出制御装置、101　磁性を有するステンレス板（磁性を有する部材）、102　支持台（部材変形手段）、103　電磁石（部材変形手段）。

【図1】

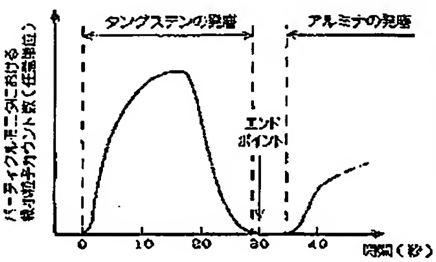


1：ウエハ
4：成膜チャンバ（プロセスチャンバ）
12：排気管
15：パーティクルモニタ

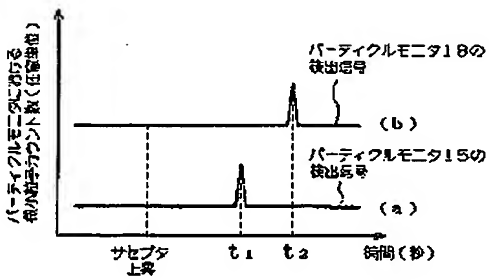
【図6】



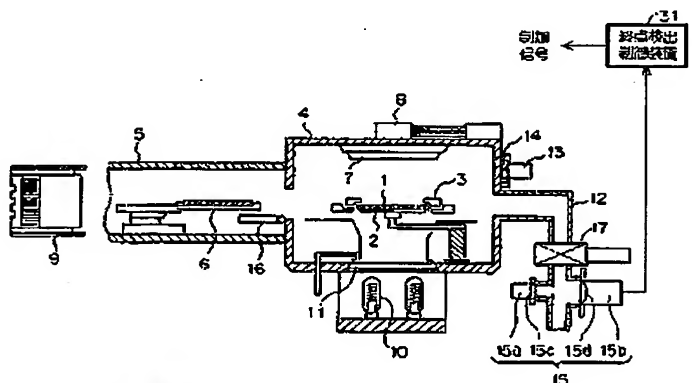
【図2】



【図5】

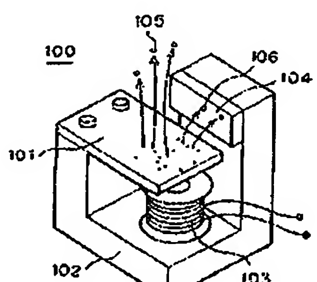


【図3】

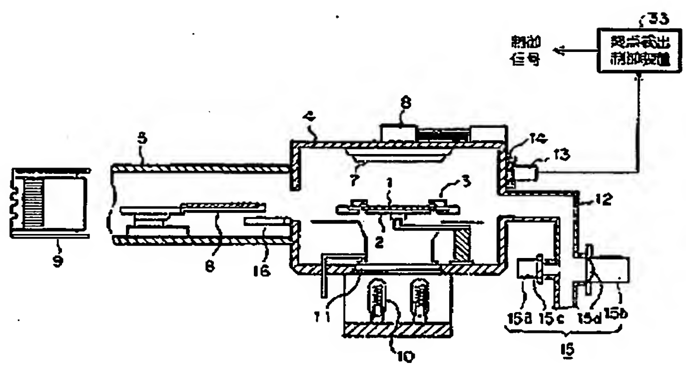


17：遮断弁

【図7】

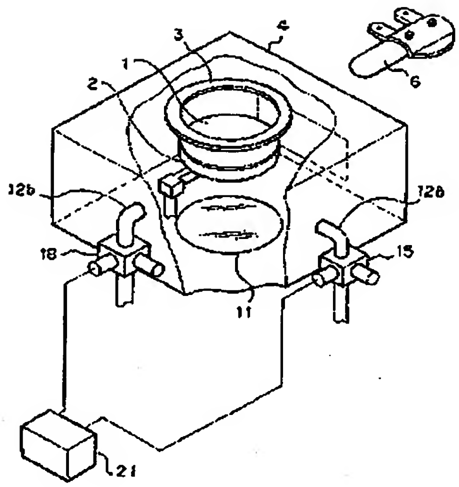


【図8】



101：磁性を有するステンレス板（磁性を有する部材）
102：支持台（部材変形手段）
103：電磁石（部材変形手段）

【図4】



21：信号処理装置

フロントページの続き

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CLAIMS

[Claim(s)]

[Claim 1] The process chamber which cleans the deposit which contained the semi-conductor wafer inside, and etched the thin film deposited on this semi-conductor wafer using the plasma, or adhered to the interior using the plasma, The exhaust pipe which exhausts the gas in this process chamber, and the particle monitor which measures the particle number which it is prepared in this exhaust pipe and generated at the time of the above-mentioned plasma etching or plasma cleaning, Semiconductor fabrication machines and equipment equipped with the terminal point detection control unit which the particle number which this particle monitor measures is observed [control unit] by time series, and the terminal point of the above-mentioned plasma etching or plasma cleaning is detected [control unit], and terminates the above-mentioned plasma etching or plasma cleaning.

[Claim 2] Semiconductor fabrication machines and equipment according to claim 1 characterized by preparing the latching valve which intercepts between the above-mentioned process chamber and the above-mentioned particle monitors to the exhaust pipe between a process chamber and a particle monitor.

[Claim 3] Semiconductor fabrication machines and equipment according to claim 2 characterized by using a gate valve or a ball valve as a latching valve.

[Claim 4] The process chamber which cleans the deposit which contained the semi-conductor wafer inside, and etched the thin film deposited on this semi-conductor wafer using the plasma, or adhered to the interior using the plasma, The exhaust pipe which exhausts the gas in this process

chamber, and the particle monitor which measures the particle number which it is prepared in this exhaust pipe and generated at the time of the above-mentioned plasma etching or plasma cleaning, Observe the particle number which this particle monitor measures by time series, and the terminal point of the above-mentioned plasma etching or plasma cleaning is detected. They are semiconductor fabrication machines and equipment equipped with the terminal point detection control unit which terminates the above-mentioned plasma etching or plasma cleaning. Semiconductor fabrication machines and equipment equipped with the signal processor which forms two or more exhaust pipes in the above-mentioned process chamber, installs a particle monitor in each exhaust pipe, and computes a raising dust location based on the raising dust time-of-day detecting signal from two or more above-mentioned particle monitors.

[Claim 5] Raising dust evaluation equipment equipped with the member which has the magnetism which carried out blasting processing of the front face using the abrasive of a predetermined particle size, and the member deformation means to which this member is made to deform into and residual abrasive is made to emit.

[Claim 6] Raising dust evaluation equipment according to claim 5 characterized by constituting from susceptor which supports the stainless plate which uses stainless steel for the ingredient of the member which has the magnetism which carried out blasting processing of the front face, and has magnetism for a member deformation means in the shape of a cantilever, and an electromagnet the free end of a stainless plate is made [electromagnet] to attract and repel [electromagnet].

[Claim 7] The raising dust evaluation approach characterized by proofreading the flying speed of a particle by installing at least one raising dust evaluation equipment according to claim 5 or 6 in the process chamber of semiconductor fabrication machines and equipment given [of claim 1 to the claims 4] in any 1 term, operating this raising dust evaluation equipment in a vacuum or a predetermined process gas ambient atmosphere, generating many particles, and detecting these particles with a particle monitor.

TECHNICAL FIELD

[Field of the Invention] This invention relates to raising dust evaluation equipment and the raising dust evaluation approach at a semiconductor-fabrication-machines-and-equipment list.

PRIOR ART

[Description of the Prior Art] CVD (Chemical Vapor Deposition) The tungsten (W) which formed membranes by law is used as wiring film of semiconductor integrated circuit equipment in order to show the outstanding step coverage nature. Drawing 8 is the cross-section block diagram showing typically the conventional tungsten CVD system shown in JP,6-188193,A. In drawing, the wafer with which 1 consists of semi-conductors, such as silicon, the susceptor which 2 lays a wafer 1 and is supported, and 3 are a shadow ring for masking the wafer 1 periphery section and forming the section non-formed membranes at the time of membrane formation, while sticking a wafer 1 to a susceptor 2. The spare room prepared in order to deliver a wafer 1, without 4 not breaking a membrane formation chamber between the membrane formation chamber 4 and the exterior, but 5 breaking a vacuum, The wafer carrier-robot arm to which 6 delivers a wafer 1 between the membrane formation chamber 4 and the exterior, The porous nozzle head to which 7 introduces gas in the membrane formation chamber 4 and by which many holes were formed in the front face, The gas supply system to which 8 supplies gas to the porous nozzle head 7, the wafer cassette whose conveyance 9 contained the wafer 1 of predetermined number of sheets, and was enabled, the lamp with which 10 heats a susceptor 2, and 11 are the lamp windows established in the wall of the membrane formation chamber 4 between a lamp 10 and a susceptor 2.
[0003] The exhaust pipe with which 12 exhausts the gas in the membrane formation chamber 4 out of equipment, the end point detector with which

13 detects the end point (terminal point) of plasma cleaning, the aperture by which 14 was formed in the wall equipped with the end point detector 13 of the membrane formation chamber 4, and 15 are particle monitors, and consist of laser radiation system 15a, detector 15b, and apertures 15c and 15d. 16 is the slit bulb which it is prepared in order to maintain the airtightness between the membrane formation chamber 4 and a spare room 5, and can be opened at the time of taking-out close [of a wafer 1]. 33 is a terminal point detection control unit which outputs the control signal which controls termination of plasma cleaning based on the end point detecting signal of the plasma cleaning which the end point detector 13 detects.

[0004] Next, actuation is explained. After opening the slit bulb 16 after equipping a spare room 5 with the wafer cassette 9 and intercepting a spare room 5 from the open air, and making a spare room 5 and the membrane formation chamber 4 into this atmospheric pressure, a wafer 1 is laid on the one-sheet ejection susceptor 2 from the wafer cassette 9 using the wafer carrier-robot arm 6. Subsequently, a susceptor 2 is raised and the shadow ring 3 is made to put on the periphery section of a wafer 1. Since the temperature up of the susceptor 2 is beforehand carried out by the radiant heat of a lamp 10, the wafer 1 laid on the susceptor 2 reaches predetermined temperature promptly by heat conduction from a susceptor 2. Reactant gas is sprayed on wafer 1 front face from the porous nozzle head 7 in this condition, and a tungsten thin film is formed. As reactant gas, the mixed gas of 6 mono-silane (SiH_4) and tungsten fluoride (WF_6) is used. After membrane formation of the tungsten thin film of predetermined thickness is completed on wafer 1 front face, a series of processings are completed by removing a wafer 1 from a susceptor 2 and returning it to a spare room 5 using the wafer carrier-robot arm 6.

[0005] With the conventional tungsten CVD system shown in drawing 8 , it is WF_6 also in the front face of a part with high temperature among the configuration members of equipments, such as the shadow ring 3, and a side face of a susceptor 2, a wall of the membrane formation chamber 4, in addition to wafer 1. Gas pyrolyzes and the tungsten film adheres. In order to remove this tungsten film, plasma cleaning is usually performed. Plasma cleaning is NF_3 in the membrane formation chamber 4 immediately after processing one wafer 1. Gas is introduced, the plasma is generated,

and the tungsten film which adhered to the configuration member of equipment by this plasma is etched and removed. It lets the porous nozzle head 7 pass, and, specifically, is NF3 in the membrane formation chamber 4. Gas is introduced, high-frequency voltage is impressed between the porous nozzle head 7 and a susceptor 2, and the plasma is generated. It is NF3 by this plasma discharge. Gas is decomposed, F radical (active species) is formed, and the tungsten film is etched, when this F radical reacts with a tungsten and generates an volatile tungsten fluoride. The generated tungsten fluoride is discharged out of the membrane formation chamber 4 through an exhaust pipe 12.

[0006] Moreover, in the tungsten CVD system shown in drawing 8 , it originates in fluctuation of process conditions and process gas starts unexpected vapor growth, a minute particle occurs, or it originates in poor plasma cleaning, peeling of the tungsten film occurs, and a minute particle occurs in equipment. If these minute particles adhere to a wafer 1, the integrated circuit device under manufacture will be made to cause abnormalities of operation, and it will become the cause of a yield fall. In order to detect generating of the minute particle within equipment promptly and to stop generating of a poor product to the minimum, the particle monitor 15 is used. Since the particle monitor 15 can detect the minute particle which rides the flow of process gas and passes through the inside of an exhaust pipe 12, it can know that the minute particle occurred within equipment. When the particle monitor 15 detects a minute particle and the raising dust within equipment is discovered by that cause, product processing is stopped immediately, atmospheric-air disconnection of the membrane formation chamber 4 is carried out, wet screening of the interior is carried out, and the source of raising dust in equipment is removed.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] Although terminal point detection of plasma cleaning was performed by detecting change of luminescence of F radical in the plasma using the end point detector 13 since the conventional semiconductor fabrication machines and equipment were constituted as mentioned above If the processing number of sheets

of a wafer 1 increases, in order that the thickness of the tungsten deposited on the aperture 14 of the end point detector 13 may increase, an aperture 14 may bloom cloudy and luminescence from the plasma may not fully carry out incidence to the end point detector 13, The technical problem that poor detection of an end point arose occurred.

[0008] Moreover, when the processing number of sheets of a wafer 1 increased about the particle monitor 15, the thickness of the tungsten deposited on Apertures 15c and 15d increased, the aperture bloomed cloudy, the laser beam reinforcement irradiated by the minute particle which passes through the inside of an exhaust pipe 12 from laser radiation system 15a falls, or the technical problem that the detection ratio of the scattered light from a minute particle fell occurred.

[0009] Furthermore, since the particle monitor 15 is brought as much as possible close to the membrane formation chamber 4 and is installed in order to raise the detection precision of a minute particle with conventional equipment, when the apertures 15c and 15d of the particle monitor 15 bloom cloudy, operation of equipment is suspended, atmospheric-air disconnection must be carried out and the membrane formation chamber 4 must be cleaned. Therefore, since membrane formation processing was not completed during cleaning, the technical problem that the operating ratio of equipment fell occurred.

[0010] Furthermore, it was difficult to only detect that the particle monitor 15 had raising dust within equipment, and to pinpoint a raising dust part. Since the direction of the location gap could not be specified even when the location gap of the conveyance way of a wafer 1 had occurred since the information in which part in equipment raising dust occurred was not specifically able to be acquired for example, the technical problem that a cure was not taken occurred.

[0011] Furthermore, since proofreading of the detection precision of the particle monitor 15 was usually performed using the standard particle generation source in the atmospheric-pressure condition and the refractive index etc. differed from the inside of the vacuum which actually uses the particle monitor 15, or low-pressure process gas, the technical problem that proofreading of the detection precision of the particle monitor 15 in a real service condition could not be performed occurred.

[0012] It aims at this invention having been made in order to solve the

above technical problems, and etching and end point detection of plasma cleaning being stabilized over a long period of time, and acquiring raising dust evaluation equipment and the raising dust evaluation approach in a possible semiconductor-fabrication-machines-and-equipment list.

MEANS

[Means for Solving the Problem] The semiconductor fabrication machines and equipment concerning invention according to claim 1 are the etching system which etches the thin film which was equipped with the process chamber, contained the semi-conductor wafer to that interior, and was deposited on this semi-conductor wafer using the plasma, or membrane formation equipment which makes a thin film deposit on a semi-conductor wafer. In the case of an etching system, a plasma-etching process is applicable, and, in the case of membrane formation equipment, the plasma cleaning which cleans the deposit adhering to the interior of a process chamber using the plasma is applicable. In this invention, the particle number which the particle monitor formed in the exhaust pipe which exhausts the gas in a process chamber generates at the time of plasma etching or plasma cleaning is measured, this measurement value is observed by time series with a terminal point detection control device, the terminal point of plasma etching or plasma cleaning is detected, and plasma etching or plasma cleaning is terminated.
[0014] The semiconductor fabrication machines and equipment concerning invention according to claim 2 prepare the latching valve which intercepts between these process chamber and particle monitors to the exhaust pipe between a process chamber and a particle monitor.
[0015] A gate valve or a ball valve is used for the semiconductor fabrication machines and equipment concerning invention according to claim 3 as a latching valve.
[0016] The semiconductor fabrication machines and equipment concerning invention according to claim 4 use that basic configuration as semiconductor fabrication machines and equipment according to claim 1 in common, form two or more exhaust pipes in a process chamber, install a particle monitor in each exhaust pipe, and are equipped with the signal

processor which computes a raising dust location based on the raising dust time-of-day detecting signal from two or more of these particle monitors.

[0017] The raising dust evaluation equipment concerning invention according to claim 5 is equipped with the member which has the magnetism which carried out blasting processing of the front face using the abrasive of a predetermined particle size, and the member deformation means to which this member is made to deform into and residual abrasive is made to emit.

[0018] The raising dust evaluation equipment concerning invention according to claim 6 uses stainless steel for the ingredient of the member which has the magnetism which carried out blasting processing of the front face, and consists of susceptor which supports the stainless plate which has magnetism for a member deformation means in the shape of a cantilever, and an electromagnet the free end of a stainless plate is made [electromagnet] to attract and repel [electromagnet].

[0019] The raising dust evaluation approach concerning invention according to claim 7 in the process chamber of the semiconductor fabrication machines and equipment concerning invention given [of claim 1 to the claims 4] in any 1 term At least one raising dust evaluation equipment concerning invention according to claim 5 or 6 is installed. The flying speed of a particle is proofread by operating this raising dust evaluation equipment in a vacuum or a predetermined process gas ambient atmosphere, generating many particles, and detecting these particles with a particle monitor.

[0020]

[Embodiment of the Invention] Hereafter, one gestalt of implementation of this invention is explained.

Gestalt 1. drawing 1 of operation is drawing showing the semiconductor fabrication machines and equipment by the gestalt 1 of implementation of this invention, and shows the example which applied this invention to the CVD system. In drawing, the wafer with which 1 consists of semi-conductors, such as silicon, the susceptor which 2 lays a wafer 1 and is supported, and 3 are a shadow ring for masking the periphery section of a wafer 1 and forming the section non-formed membranes at the time of membrane formation, while sticking a wafer 1 to a susceptor 2. In order to

deliver a wafer 1, without 4 not breaking a membrane formation chamber (process chamber) between the membrane formation chamber 4 and the exterior, but 5 breaking a vacuum, the prepared spare room, the wafer carrier-robot arm to which 6 delivers a wafer 1 between the membrane formation chamber 4 and the exterior, and 7 are porous nozzle heads which introduce gas in the membrane formation chamber 4 and by which many holes were formed in the front face, and spray reactant gas all over a wafer 1.

[0021] The gas supply system to which 8 supplies gas from the source of gas supply (not shown) to the porous nozzle head 7, The wafer cassette whose conveyance 9 contains the wafer 1 of predetermined number of sheets, and is enabled, A lamp for 10 to heat a susceptor 2, the lamp window where 11 was prepared in the wall of the membrane formation chamber 4 between a lamp 10 and a susceptor 2, The exhaust pipe with which 12 exhausts the gas in the membrane formation chamber 4 out of equipment, the end point detector with which 13 detects the termination time of membrane formation, The aperture by which 14 was formed in the wall of the membrane formation chamber 4 equipped with the end point detector 13, and 15 are particle monitors, and consist of laser radiation system 15a, detector 15b, and apertures 15c and 15d. 16 is the slit bulb which it is prepared in order to maintain the airtightness between the membrane formation chamber 4 and a spare room 5, and can be opened at the time of taking-out close [of a wafer 1]. 31 is a terminal point detection control unit which outputs a control signal to each part of equipment based on a detection result while it inputs the minute particle number-of-counts signal which the particle monitor 15 outputs and detects the end point of plasma cleaning.

[0022] Next, actuation is explained. After equipping a spare room 5 with the wafer cassette 9 first and intercepting a spare room 5 from the open air, the slit bulb 16 is opened and a spare room 5 and the membrane formation chamber 4 are made into this atmospheric pressure. The inside of the membrane formation chamber 4 is exhausted to the pressure of 10mTorr(s) (about 1Pa) extent using the evacuation equipment which is not illustrated, for example, a mechanical booster pump. Subsequently, after laying a wafer 1 on the one-sheet ejection susceptor 2 from the wafer cassette 9 using the wafer carrier-robot arm 6, a susceptor 2 is raised and

the shadow ring 3 is made to put on the periphery section of a wafer 1. Since the temperature up of the susceptor 2 is beforehand carried out by the radiant heat of a lamp 10, the wafer 1 laid on the susceptor 2 reaches predetermined temperature (400-degreeC thru/or 500-degreeC) promptly by heat conduction from a susceptor 2. Reactant gas is sprayed on wafer 1 front face from the porous nozzle head 7 in this condition, and a tungsten thin film is deposited.

[0023] It explains using the example which makes up for the contact hole formed on the wafer 1 in the example of a tungsten membrane formation process with a tungsten (W). the gas which mixed mono-silane (SiH_4) gas and 6 fluoride [tungsten] (WF_6) gas by the ratio of 1:3 in order to form the nucleus of a tungsten (W) on a wafer 1 first -- carrier gas -- an argon (Ar) -- using -- a wafer 1 top -- for 30 seconds -- or it supplies for 100 seconds. next, the gas which 1:5 came out of the gas, for example, 6 fluoride [tungsten] (WF_6) gas, and hydrogen (H_2) of good conditions of step coverage (step coverage nature) comparatively, and was mixed -- a wafer 1 top -- for 50 seconds -- or it supplies for 200 seconds. The good tungsten film of stopgap nature accumulates on the thickness which is about 0.5-1.0 micrometers according to this process. After membrane formation termination, using the wafer carrier-robot arm 6, a wafer 1 is removed from a susceptor 2 and returned to a spare room 5. A series of (Tungsten W) membrane formation processes by the above are completed.

[0024] In order that WF_6 gas may pyrolyze [with the tungsten CVD system concerning the gestalt 1 of this operation mentioned above] also on the front face of a part with high temperature like conventional equipment among the configuration members of equipments, such as a front face of the shadow ring 3, a side face of a susceptor 2, and a wall of the membrane formation chamber 4, in addition to wafer 1 front face, the tungsten film accumulates there. If the tungsten film has accumulated on these members, since it is inconvenient to execution of the following tungsten membrane formation process, it is necessary to remove. Therefore, plasma cleaning is usually performed.

[0025] Plasma cleaning introduces 3 nitrogen-fluoride (NF_3) gas in the membrane formation chamber 4 immediately after processing one wafer 1, generates the plasma, and etches and removes the tungsten film deposited on the configuration member front face of equipment by this

plasma. It specifically lets the porous nozzle head 7 pass, and is NF3 in the membrane formation chamber 4. Gas is introduced, high-frequency voltage is impressed between the porous nozzle head 7 and a susceptor 2, and the plasma is generated. It is NF3 by this plasma discharge. Gas is decomposed, F radical (active species) is formed, and the tungsten film is etched, when this F radical reacts with a tungsten and generates an volatile tungsten fluoride. The generated tungsten fluoride is discharged out of the membrane formation chamber 4 through an exhaust pipe 12.
[0026] With the gestalt 1 of this operation, detection of the end point of plasma cleaning is performed, when the terminal point detection control unit 31 observes serially the counted value of the minute particle which the particle monitor 15 counts. Drawing 2 is the graphical representation showing the example of observation of the number of counts of the minute particle which used and measured the particle monitor 15 at the time of plasma cleaning. In drawing, the elapsed time (second unit) and the axis of ordinate to which an axis of abscissa makes the starting point the time of the raising dust of a tungsten being observed are the minute particle number of counts (arbitration unit) in the particle monitor 15. Since the minute particle of a tungsten occurs with an volatile tungsten fluoride while the tungsten film remains to the wall and configuration member of the membrane formation chamber 4 in early stages of plasma cleaning so that drawing 2 may show, the raising dust of a tungsten is observed. The amount of raising dust of a tungsten increases from immediately after initiation of plasma cleaning, after it attaches a peak after a certain time amount progress, it starts to decrease, and it is no longer observed at all at a certain time. This is because generating (raising dust of a tungsten) of a tungsten minute particle is lost, when the tungsten film deposited on the wall of the membrane formation chamber 4 etc. is removed completely.
[0027] If plasma cleaning is furthermore continued, the component of the membrane formation chamber 4, for example, the minute particle of alumina ceramics, will occur (raising dust of an alumina). With the gestalt 1 of this operation, time amount change of the amount of raising dust under plasma cleaning which the terminal point detection control device 31 counted with the particle monitor 15 is observed, and the time (from raising dust initiation to after [The example of drawing 1] the progress during 30 seconds) of the first raising dust being lost, at i.e., the time of

generating (raising dust of a tungsten) of the minute particle of a tungsten being lost, is judged as an end point. If an end point is judged, the terminal point detection control unit 31 will output a control signal, and will terminate plasma cleaning.

[0028] With the gestalt 1 of this operation, the number of counts of the minute particle which the particle monitor 15 measures is used for detection of the end point of plasma cleaning. Thereby, the following advantage is acquired. That is, since the particle monitor 15 is attached in the exhaust pipe 12 located in the location distant from the exoergic sections, such as a susceptor 2, a temperature rise is small and Apertures 15c and 15d cannot bloom cloudy easily. Since the particle monitor 15 always operates normally as a result, the end point of plasma cleaning is correctly detectable. Therefore, while being stabilized over a long period of time, becoming detectable [the end point of plasma cleaning] and being able to lengthen the maintenance period of equipment, the operating ratio of equipment can be raised.

[0029] In addition, although the gestalt 1 of operation mentioned above showed the example which applied this invention to the plasma cleaning in a tungsten CVD system, not only this but this invention is applicable to the process unit at large which is made to generate the plasma and performs etching and cleaning. For example, it is applicable to the membrane formation equipment of silicon oxide, a silicon nitride, the polish recon film, the tungsten silicide film, the aluminum film, and the tungsten film, or the plasma etching system of these film.

[0030] Gestalt 2. drawing 3 of operation is drawing showing the semiconductor fabrication machines and equipment by the gestalt 2 of implementation of this invention, and shows other examples which applied this invention to the CVD system. In drawing A wafer 1, a susceptor 2, the shadow ring 3, the membrane formation chamber 4, a spare room 5, the wafer carrier-robot arm 6, the porous nozzle head 7, a gas supply system 8, the wafer cassette 9, a lamp 10, the lamp window 11, an exhaust pipe 12, the end point detector 13, an aperture 14, Since the particle monitor 15, laser radiation system 15a, detector 15b, Apertures 15c and 15d, the slit bulb 16, and the terminal point detection control unit 31 are the same as the equipment of the gestalt 1 of the above-mentioned implementation shown in drawing 1 , the explanation is omitted.

[0031] In addition to the equipment shown in drawing 1 , the tungsten CVD system concerning the gestalt 2 of this operation forms a latching valve 17 in an exhaust pipe 12. This latching valve 17 is formed between the membrane formation chamber 4 and the particle monitor 15, and it acts so that vacuum separation of the membrane formation chamber 4 and the particle monitor 15 may be carried out. Since the valve of the structure which does not bar passing of the minute particle which flies the inside of an exhaust pipe 12 from the membrane formation chamber 4 as a latching valve 17 is desirable, a gate valve and a ball valve are used, for example.
[0032] Next, actuation is explained. Although the apertures 15c and 15d of the particle monitor 15 cannot bloom cloudy easily, in order to maintain equipment at the optimal condition, it is necessary to clean these apertures 15c and 15d periodically. By closing a latching valve 17, cleaning of the apertures 15c and 15d of the particle monitor 15 is performed, where it separated the membrane formation chamber 4 and the particle monitor 15 and the membrane formation chamber 4 is maintained at a vacuum. Thereby, since it is not exposed to atmospheric air, after cleaning of the apertures 15c and 15d of the particle monitor 15 is completed, the inside of the membrane formation chamber 4 can resume a latching valve 17, and can continue membrane formation processing of a tungsten promptly. Moreover, in case it maintains by carrying out atmospheric-air disconnection of the membrane formation chamber 4, when there is little apertures [of the particle monitor 15 / 15c and 15d] dirt, a latching valve 17 is closed and evacuation of the particle monitor 15 is carried out. By this actuation, since oxidization of an Apertures [15c and 15d] affix can be controlled, it is not necessary to clean the apertures 15c and 15d of the particle monitor 15 at the time of the maintenance of the membrane formation chamber 4.
[0033] As mentioned above, according to the gestalt 2 of this operation, since the latching valve 17 was formed between the membrane formation chamber 4 and the particle monitor 15, it becomes possible to maintain the inside of the membrane formation chamber 4 at a vacuum during the maintenance of the particle monitor 15. Since it becomes possible to, start the equipment after maintenance termination immediately as a result, decline in the operating ratio of the equipment accompanying the maintenance of the particle monitor 15 can be stopped to the minimum.

Moreover, since the cleaning frequency of equipment can be made low, the operating ratio of equipment can be raised.

[0034] Gestalt 3. drawing 4 of operation is the fracture perspective view of the principal part of the CVD system by the gestalt 3 of implementation of this invention, and is set to drawing. 1 -- a wafer and 2 -- for a membrane formation chamber and 6, although an exhaust pipe, and 15 and 18 are particle monitors, a susceptor and 3 a shadow ring and 4 [a wafer carrier-robot arm and 11] [a lamp window, and 12a and 12b] Since these components are the same as the thing of the equipment concerning the gestalt 1 of the above-mentioned implementation shown in drawing 1 , detailed explanation is omitted.

[0035] The CVD system concerning the gestalt 3 of this operation forms two or more exhaust pipes 12a and 12b in the membrane formation chamber 4, and forms the particle monitors 15 and 18 in each exhaust pipes 12a and 12b. Drawing 4 forms two exhaust pipes 12a and 12b in the membrane formation chamber 4, and shows the example which formed the particle monitors 15 and 18 to each exhaust pipes 12a and 12b. Furthermore, the CVD system concerning the gestalt 3 of this operation is equipped with the signal processor 21 which computes the location which the particle monitors 15 and 18 processed the raising dust signal which outputs the value which counted the minute particle number, and the raising dust in the membrane formation chamber 4 generated.

[0036] Next, actuation is explained. If a location gap arises in case a wafer 1 is laid on a susceptor 2 using the wafer carrier-robot arm 6, when raising a susceptor 2 after that and putting the shadow ring 3 on a wafer 1, a wafer 1 and the shadow ring 3 will wear and carry out raising dust. The minute particle which this generates rides the flow of process gas, and is exhausted. Since the rate of flow of process gas is fixed, if it sets to v the flying speed of the minute particle mentioned above, it can be considered that v is almost fixed. Time amount t1 to which the minute particle which a wafer 1 and the shadow ring 3 wear for which and generate at the time of the rise of a susceptor 2 flies even to two particle monitors 15 and 18 And t2 It can ask to be shown in drawing 5 on the basis of the rise time of day of a susceptor 2.

[0037] The detecting signal (a) of the particle monitor 15 shown in drawing 5 and the detecting signal (b) of the particle monitor 18 are

outputted to a signal processor 21. The signal processor 21 into which a detecting signal (a) and (b) were inputted pinpoints a raising dust source location by computing the intersection K with the circle C18 of radius t2 v centering on the installation location of the particle monitor 15 centering on the circle C15 of radius t1 v, and the installation location of the particle monitor 18, as shown in drawing 6 . If the location K which raising dust generates is pinpointed, the control section (not shown) of equipment will amend the location where the wafer carrier-robot arm 6 delivers a wafer 1 so that the raising dust of the ** of a wafer 1 and the shadow ring 3 to exceed may not be canceled and carried out. Since a series of raising dust dissolution actuation mentioned above can be performed without breaking the vacuum of the membrane formation chamber 4, it can raise the operating ratio of equipment.

[0038] As mentioned above, according to the gestalt 3 of this operation, two or more particle monitors 15 and 18 and signal processors 21 are used. When [sudden at the time of wafer 1 delivery] it rubs and raising dust occurs, a raising dust location is pinpointed from the difference in the raising dust detection time which each particle monitors 15 and 18 detect. Since it enabled it to cancel without breaking the vacuum of the membrane formation chamber 4 for ** accompanying delivery of a wafer 1 to exceed based on it, the operating ratio of equipment can be improved sharply.

[0039] 102 is the raising dust evaluation equipment which 100 requires [in / gestalt 4. drawing 7 of operation is drawing showing the raising dust evaluation equipment by the gestalt 4 of implementation of this invention, and / drawing] for this invention, the stainless plate (member which has magnetism) which has the magnetism to which 101 performed blasting processing using abrasive, and susceptor which supports the stainless plate 101 which has magnetism in the shape of a cantilever.

EFFECT OF THE INVENTION

[Effect of the Invention] Plasma etching [according to invention according to claim 1] in an etching system, Or the particle number which the particle monitor which established the terminal point of the plasma

cleaning in membrane formation equipment in the exhaust pipe which exhausts the gas in a process chamber generates at the time of plasma etching or plasma cleaning is measured. Since it constituted so that a terminal point detection control unit might observe and detect this measurement value by time series While becoming possible to be stabilized over a long period of time and to detect the end point of plasma cleaning and being able to lengthen the maintenance period of equipment, there is effectiveness which raises the operating ratio of equipment.

[0046] According to invention according to claim 2, it becomes possible to maintain the inside of a process chamber at it during the maintenance of a particle monitor at a vacuum, since it constituted in the exhaust pipe between a process chamber and a particle monitor so that the latching valve which intercepts between these process chamber and particle monitors might be prepared. Since it becomes possible to, start the equipment after maintenance termination immediately as a result, there is effectiveness which can stop decline in the operating ratio of the equipment accompanying the maintenance of a particle monitor to the minimum.

[0047] Since according to invention according to claim 3 it constituted as a latching valve so that a gate valve or a ball valve might be used, there is effectiveness which does not bar the flight of the minute particle from a process chamber.

[0048] According to invention according to claim 4, two or more exhaust pipes are formed in a process chamber. Since it constituted so that it might have the signal processor which installs a particle monitor in each exhaust pipe, and computes a raising dust location based on the raising dust time-of-day detecting signal from two or more of these particle monitors Since it constituted so that a raising dust location might be pinpointed from the difference in the raising dust detection time which two or more particle monitors detect when [which was sudden at the time of wafer delivery] it rubbed and raising dust occurred In ** accompanying wafer delivery based on the specific result of a raising dust location to exceed, since the vacuum of a process chamber can be canceled without breaking, it is effective in the operating ratio of equipment improving sharply.

[0049] Since according to invention according to claim 5 it constituted so

that it might have the member which has the magnetism which carried out blasting processing of the front face using the abrasive of a predetermined particle size, and the member deformation means to which this member is made to deform into and residual abrasive is made to emit, since this raising dust evaluation equipment can operate in a vacuum or low-pressure process gas, it is under a real operating environment, and it can generate the particle of a particle size predetermined to the timing of arbitration. Therefore, there is effectiveness which can proofread detection precision of a particle monitor in a high precision.

[0050] Since according to invention according to claim 6 it constituted so that it might have the susceptor which supports the stainless plate which uses stainless steel for the ingredient of the member which has the magnetism which carried out blasting processing of the front face, and has magnetism for a member deformation means in the shape of a cantilever, and the electromagnet the free end of a stainless plate is made [electromagnet] to attract and repel [electromagnet], it is effective in the high raising dust evaluation equipment of practicality being realizable with a simple configuration.

[0051] According to invention according to claim 7, in the process chamber of the semiconductor fabrication machines and equipment concerning invention given [of claim 1 to the claims 4] in any 1 term At least one raising dust evaluation equipment concerning invention according to claim 5 or 6 is installed. Since it constituted so that the flying speed of a particle might be proofread by operating this raising dust evaluation equipment in a vacuum or a predetermined process gas ambient atmosphere, generating many particles, and detecting these particles with a particle monitor When the flying speed of a minute particle differs from the rate of flow of process gas, Since the flying speed of a minute particle can be amended by observing the particle which installs raising dust evaluation equipment in the location corresponding to the location which it rubs and raising dust tends to generate, is operated in pulse, and is generated with two or more particle monitors It is effective in raising the precision which pinpoints the generating location of the raising dust generated suddenly.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to raising dust evaluation equipment and the raising dust evaluation approach at a semiconductor-fabrication-machines-and-equipment list.

[0002]

[Description of the Prior Art] CVD (Chemical Vapor Deposition) The tungsten (W) which formed membranes by law is used as wiring film of semiconductor integrated circuit equipment in order to show the outstanding step coverage nature. Drawing 8 is the cross-section block diagram showing typically the conventional tungsten CVD system shown in JP,6-188193,A. In drawing, the wafer with which 1 consists of semi-conductors, such as silicon, the susceptor which 2 lays a wafer 1 and is supported, and 3 are a shadow ring for masking the wafer 1 periphery section and forming the section non-formed membranes at the time of membrane formation, while sticking a wafer 1 to a susceptor 2. The spare room prepared in order to deliver a wafer 1, without 4 not breaking a membrane formation chamber between the membrane formation chamber 4 and the exterior, but 5 breaking a vacuum, The wafer carrier-robot arm to which 6 delivers a wafer 1 between the membrane formation chamber 4 and the exterior, The porous nozzle head to which 7 introduces gas in the membrane formation chamber 4 and by which many holes were formed in the front face, The gas supply system to which 8 supplies gas to the porous nozzle head 7, the wafer cassette whose conveyance 9 contained the wafer 1 of predetermined number of sheets, and was enabled, the lamp with which 10 heats a susceptor 2, and 11 are the lamp windows established in the wall of the membrane formation chamber 4 between a lamp 10 and a susceptor 2.

[0003] The exhaust pipe with which 12 exhausts the gas in the membrane formation chamber 4 out of equipment, the end point detector with which 13 detects the end point (terminal point) of plasma cleaning, the aperture by which 14 was formed in the wall equipped with the end point detector

13 of the membrane formation chamber 4, and 15 are particle monitors, and consist of laser radiation system 15a, detector 15b, and apertures 15c and 15d. 16 is the slit bulb which it is prepared in order to maintain the airtightness between the membrane formation chamber 4 and a spare room 5, and can be opened at the time of taking-out close [of a wafer 1]. 33 is a terminal point detection control unit which outputs the control signal which controls termination of plasma cleaning based on the end point detecting signal of the plasma cleaning which the end point detector 13 detects.

[0004] Next, actuation is explained. After opening the slit bulb 16 after equipping a spare room 5 with the wafer cassette 9 and intercepting a spare room 5 from the open air, and making a spare room 5 and the membrane formation chamber 4 into this atmospheric pressure, a wafer 1 is laid on the one-sheet ejection susceptor 2 from the wafer cassette 9 using the wafer carrier-robot arm 6. Subsequently, a susceptor 2 is raised and the shadow ring 3 is made to put on the periphery section of a wafer 1. Since the temperature up of the susceptor 2 is beforehand carried out by the radiant heat of a lamp 10, the wafer 1 laid on the susceptor 2 reaches predetermined temperature promptly by heat conduction from a susceptor 2. Reactant gas is sprayed on wafer 1 front face from the porous nozzle head 7 in this condition, and a tungsten thin film is formed. As reactant gas, the mixed gas of 6 mono-silane (SiH4) and tungsten fluoride (WF6) is used. After membrane formation of the tungsten thin film of predetermined thickness is completed on wafer 1 front face, a series of processings are completed by removing a wafer 1 from a susceptor 2 and returning it to a spare room 5 using the wafer carrier-robot arm 6.

[0005] With the conventional tungsten CVD system shown in drawing 8 , it is WF6 also in the front face of a part with high temperature among the configuration members of equipments, such as the shadow ring 3, and a side face of a susceptor 2, a wall of the membrane formation chamber 4, in addition to wafer 1. Gas pyrolyzes and the tungsten film adheres. In order to remove this tungsten film, plasma cleaning is usually performed. Plasma cleaning is NF3 in the membrane formation chamber 4 immediately after processing one wafer 1. Gas is introduced, the plasma is generated, and the tungsten film which adhered to the configuration member of equipment by this plasma is etched and removed. It lets the porous nozzle

head 7 pass, and, specifically, is NF3 in the membrane formation chamber 4. Gas is introduced, high-frequency voltage is impressed between the porous nozzle head 7 and a susceptor 2, and the plasma is generated. It is NF3 by this plasma discharge. Gas is decomposed, F radical (active species) is formed, and the tungsten film is etched, when this F radical reacts with a tungsten and generates an volatile tungsten fluoride. The generated tungsten fluoride is discharged out of the membrane formation chamber 4 through an exhaust pipe 12.

[0006] Moreover, in the tungsten CVD system shown in drawing 8 , it originates in fluctuation of process conditions and process gas starts unexpected vapor growth, a minute particle occurs, or it originates in poor plasma cleaning, peeling of the tungsten film occurs, and a minute particle occurs in equipment. If these minute particles adhere to a wafer 1, the integrated circuit device under manufacture will be made to cause abnormalities of operation, and it will become the cause of a yield fall. In order to detect generating of the minute particle within equipment promptly and to stop generating of a poor product to the minimum, the particle monitor 15 is used. Since the particle monitor 15 can detect the minute particle which rides the flow of process gas and passes through the inside of an exhaust pipe 12, it can know that the minute particle occurred within equipment. When the particle monitor 15 detects a minute particle and the raising dust within equipment is discovered by that cause, product processing is stopped immediately, atmospheric-air disconnection of the membrane formation chamber 4 is carried out, wet screening of the interior is carried out, and the source of raising dust in equipment is removed.

[0007]

[Problem(s) to be Solved by the Invention] Although terminal point detection of plasma cleaning was performed by detecting change of luminescence of F radical in the plasma using the end point detector 13 since the conventional semiconductor fabrication machines and equipment were constituted as mentioned above If the processing number of sheets of a wafer 1 increases, in order that the thickness of the tungsten deposited on the aperture 14 of the end point detector 13 may increase, an aperture 14 may bloom cloudy and luminescence from the plasma may not fully carry out incidence to the end point detector 13, The technical problem that poor detection of an end point arose occurred.

[0008] Moreover, when the processing number of sheets of a wafer 1 increased about the particle monitor 15, the thickness of the tungsten deposited on Apertures 15c and 15d increased, the aperture bloomed cloudy, the laser beam reinforcement irradiated by the minute particle which passes through the inside of an exhaust pipe 12 from laser radiation system 15a falls, or the technical problem that the detection ratio of the scattered light from a minute particle fell occurred.
[0009] Furthermore, since the particle monitor 15 is brought as much as possible close to the membrane formation chamber 4 and is installed in order to raise the detection precision of a minute particle with conventional equipment, when the apertures 15c and 15d of the particle monitor 15 bloom cloudy, operation of equipment is suspended, atmospheric-air disconnection must be carried out and the membrane formation chamber 4 must be cleaned. Therefore, since membrane formation processing was not completed during cleaning, the technical problem that the operating ratio of equipment fell occurred.
[0010] Furthermore, it was difficult to only detect that the particle monitor 15 had raising dust within equipment, and to pinpoint a raising dust part. Since the direction of the location gap could not be specified even when the location gap of the conveyance way of a wafer 1 had occurred since the information in which part in equipment raising dust occurred was not specifically able to be acquired for example, the technical problem that a cure was not taken occurred.
[0011] Furthermore, since proofreading of the detection precision of the particle monitor 15 was usually performed using the standard particle generation source in the atmospheric-pressure condition and the refractive index etc. differed from the inside of the vacuum which actually uses the particle monitor 15, or low-pressure process gas, the technical problem that proofreading of the detection precision of the particle monitor 15 in a real service condition could not be performed occurred.
[0012] It aims at this invention having been made in order to solve the above technical problems, and etching and end point detection of plasma cleaning being stabilized over a long period of time, and acquiring raising dust evaluation equipment and the raising dust evaluation approach in a possible semiconductor-fabrication-machines-and-equipment list.
[0013]

[Means for Solving the Problem] The semiconductor fabrication machines and equipment concerning invention according to claim 1 are the etching system which etches the thin film which was equipped with the process chamber, contained the semi-conductor wafer to that interior, and was deposited on this semi-conductor wafer using the plasma, or membrane formation equipment which makes a thin film deposit on a semi-conductor wafer. In the case of an etching system, a plasma-etching process is applicable, and, in the case of membrane formation equipment, the plasma cleaning which cleans the deposit adhering to the interior of a process chamber using the plasma is applicable. In this invention, the particle number which the particle monitor formed in the exhaust pipe which exhausts the gas in a process chamber generates at the time of plasma etching or plasma cleaning is measured, this measurement value is observed by time series with a terminal point detection control device, the terminal point of plasma etching or plasma cleaning is detected, and plasma etching or plasma cleaning is terminated.
[0014] The semiconductor fabrication machines and equipment concerning invention according to claim 2 prepare the latching valve which intercepts between these process chamber and particle monitors to the exhaust pipe between a process chamber and a particle monitor.
[0015] A gate valve or a ball valve is used for the semiconductor fabrication machines and equipment concerning invention according to claim 3 as a latching valve.
[0016] The semiconductor fabrication machines and equipment concerning invention according to claim 4 use that basic configuration as semiconductor fabrication machines and equipment according to claim 1 in common, form two or more exhaust pipes in a process chamber, install a particle monitor in each exhaust pipe, and are equipped with the signal processor which computes a raising dust location based on the raising dust time-of-day detecting signal from two or more of these particle monitors.
[0017] The raising dust evaluation equipment concerning invention according to claim 5 is equipped with the member which has the magnetism which carried out blasting processing of the front face using the abrasive of a predetermined particle size, and the member deformation means to which this member is made to deform into and residual abrasive

is made to emit.
[0018] The raising dust evaluation equipment concerning invention according to claim 6 uses stainless steel for the ingredient of the member which has the magnetism which carried out blasting processing of the front face, and consists of susceptor which supports the stainless plate which has magnetism for a member deformation means in the shape of a cantilever, and an electromagnet the free end of a stainless plate is made [electromagnet] to attract and repel [electromagnet].
[0019] The raising dust evaluation approach concerning invention according to claim 7 in the process chamber of the semiconductor fabrication machines and equipment concerning invention given [of claim 1 to the claims 4] in any 1 term At least one raising dust evaluation equipment concerning invention according to claim 5 or 6 is installed. The flying speed of a particle is proofread by operating this raising dust evaluation equipment in a vacuum or a predetermined process gas ambient atmosphere, generating many particles, and detecting these particles with a particle monitor.
[0020]
[Embodiment of the Invention] Hereafter, one gestalt of implementation of this invention is explained.
Gestalt 1. drawing 1 of operation is drawing showing the semiconductor fabrication machines and equipment by the gestalt 1 of implementation of this invention, and shows the example which applied this invention to the CVD system. In drawing, the wafer with which 1 consists of semi-conductors, such as silicon, the susceptor which 2 lays a wafer 1 and is supported, and 3 are a shadow ring for masking the periphery section of a wafer 1 and forming the section non-formed membranes at the time of membrane formation, while sticking a wafer 1 to a susceptor 2. In order to deliver a wafer 1, without 4 not breaking a membrane formation chamber (process chamber) between the membrane formation chamber 4 and the exterior, but 5 breaking a vacuum, the prepared spare room, the wafer carrier-robot arm to which 6 delivers a wafer 1 between the membrane formation chamber 4 and the exterior, and 7 are porous nozzle heads which introduce gas in the membrane formation chamber 4 and by which many holes were formed in the front face, and spray reactant gas all over a wafer 1.

[0021] The gas supply system to which 8 supplies gas from the source of gas supply (not shown) to the porous nozzle head 7, The wafer cassette whose conveyance 9 contains the wafer 1 of predetermined number of sheets, and is enabled, A lamp for 10 to heat a susceptor 2, the lamp window where 11 was prepared in the wall of the membrane formation chamber 4 between a lamp 10 and a susceptor 2, The exhaust pipe with which 12 exhausts the gas in the membrane formation chamber 4 out of equipment, the end point detector with which 13 detects the termination time of membrane formation, The aperture by which 14 was formed in the wall of the membrane formation chamber 4 equipped with the end point detector 13, and 15 are particle monitors, and consist of laser radiation system 15a, detector 15b, and apertures 15c and 15d. 16 is the slit bulb which it is prepared in order to maintain the airtightness between the membrane formation chamber 4 and a spare room 5, and can be opened at the time of taking-out close [of a wafer 1]. 31 is a terminal point detection control unit which outputs a control signal to each part of equipment based on a detection result while it inputs the minute particle number-of-counts signal which the particle monitor 15 outputs and detects the end point of plasma cleaning.
[0022] Next, actuation is explained. After equipping a spare room 5 with the wafer cassette 9 first and intercepting a spare room 5 from the open air, the slit bulb 16 is opened and a spare room 5 and the membrane formation chamber 4 are made into this atmospheric pressure. The inside of the membrane formation chamber 4 is exhausted to the pressure of 10mTorr(s) (about 1Pa) extent using the evacuation equipment which is not illustrated, for example, a mechanical booster pump. Subsequently, after laying a wafer 1 on the one-sheet ejection susceptor 2 from the wafer cassette 9 using the wafer carrier-robot arm 6, a susceptor 2 is raised and the shadow ring 3 is made to put on the periphery section of a wafer 1. Since the temperature up of the susceptor 2 is beforehand carried out by the radiant heat of a lamp 10, the wafer 1 laid on the susceptor 2 reaches predetermined temperature (400-degreeC thru/or 500-degreeC) promptly by heat conduction from a susceptor 2. Reactant gas is sprayed on wafer 1 front face from the porous nozzle head 7 in this condition, and a tungsten thin film is deposited.
[0023] It explains using the example which makes up for the contact hole

formed on the wafer 1 in the example of a tungsten membrane formation process with a tungsten (W). the gas which mixed mono-silane (SiH_4) gas and 6 fluoride [tungsten] (WF_6) gas by the ratio of 1:3 in order to form the nucleus of a tungsten (W) on a wafer 1 first -- carrier gas -- an argon (Ar) -- using -- a wafer 1 top -- for 30 seconds -- or it supplies for 100 seconds. next, the gas which 1:5 came out of the gas, for example, 6 fluoride [tungsten] (WF_6) gas, and hydrogen (H_2) of good conditions of step coverage (step coverage nature) comparatively, and was mixed -- a wafer 1 top -- for 50 seconds -- or it supplies for 200 seconds. The good tungsten film of stopgap nature accumulates on the thickness which is about 0.5-1.0 micrometers according to this process. After membrane formation termination, using the wafer carrier-robot arm 6, a wafer 1 is removed from a susceptor 2 and returned to a spare room 5. A series of (Tungsten W) membrane formation processes by the above are completed.
[0024] In order that WF_6 gas may pyrolyze [with the tungsten CVD system concerning the gestalt 1 of this operation mentioned above] also on the front face of a part with high temperature like conventional equipment among the configuration members of equipments, such as a front face of the shadow ring 3, a side face of a susceptor 2, and a wall of the membrane formation chamber 4, in addition to wafer 1 front face, the tungsten film accumulates there. If the tungsten film has accumulated on these members, since it is inconvenient to execution of the following tungsten membrane formation process, it is necessary to remove. Therefore, plasma cleaning is usually performed.
[0025] Plasma cleaning introduces 3 nitrogen-fluoride (NF_3) gas in the membrane formation chamber 4 immediately after processing one wafer 1, generates the plasma, and etches and removes the tungsten film deposited on the configuration member front face of equipment by this plasma. It specifically lets the porous nozzle head 7 pass, and is NF_3 in the membrane formation chamber 4. Gas is introduced, high-frequency voltage is impressed between the porous nozzle head 7 and a susceptor 2, and the plasma is generated. It is NF_3 by this plasma discharge. Gas is decomposed, F radical (active species) is formed, and the tungsten film is etched, when this F radical reacts with a tungsten and generates an volatile tungsten fluoride. The generated tungsten fluoride is discharged out of the membrane formation chamber 4 through an exhaust pipe 12.

[0026] With the gestalt 1 of this operation, detection of the end point of plasma cleaning is performed, when the terminal point detection control unit 31 observes serially the counted value of the minute particle which the particle monitor 15 counts. Drawing 2 is the graphical representation showing the example of observation of the number of counts of the minute particle which used and measured the particle monitor 15 at the time of plasma cleaning. In drawing, the elapsed time (second unit) and the axis of ordinate to which an axis of abscissa makes the starting point the time of the raising dust of a tungsten being observed are the minute particle number of counts (arbitration unit) in the particle monitor 15. Since the minute particle of a tungsten occurs with an volatile tungsten fluoride while the tungsten film remains to the wall and configuration member of the membrane formation chamber 4 in early stages of plasma cleaning so that drawing 2 may show, the raising dust of a tungsten is observed. The amount of raising dust of a tungsten increases from immediately after initiation of plasma cleaning, after it attaches a peak after a certain time amount progress, it starts to decrease, and it is no longer observed at all at a certain time. This is because generating (raising dust of a tungsten) of a tungsten minute particle is lost, when the tungsten film deposited on the wall of the membrane formation chamber 4 etc. is removed completely.
[0027] If plasma cleaning is furthermore continued, the component of the membrane formation chamber 4, for example, the minute particle of alumina ceramics, will occur (raising dust of an alumina). With the gestalt 1 of this operation, time amount change of the amount of raising dust under plasma cleaning which the terminal point detection control device 31 counted with the particle monitor 15 is observed, and the time (from raising dust initiation to after [The example of drawing 1] the progress during 30 seconds) of the first raising dust being lost, at i.e., the time of generating (raising dust of a tungsten) of the minute particle of a tungsten being lost, is judged as an end point. If an end point is judged, the terminal point detection control unit 31 will output a control signal, and will terminate plasma cleaning.
[0028] With the gestalt 1 of this operation, the number of counts of the minute particle which the particle monitor 15 measures is used for detection of the end point of plasma cleaning. Thereby, the following advantage is acquired. That is, since the particle monitor 15 is attached in

the exhaust pipe 12 located in the location distant from the exoergic sections, such as a susceptor 2, a temperature rise is small and Apertures 15c and 15d cannot bloom cloudy easily. Since the particle monitor 15 always operates normally as a result, the end point of plasma cleaning is correctly detectable. Therefore, while being stabilized over a long period of time, becoming detectable [the end point of plasma cleaning] and being able to lengthen the maintenance period of equipment, the operating ratio of equipment can be raised.

[0029] In addition, although the gestalt 1 of operation mentioned above showed the example which applied this invention to the plasma cleaning in a tungsten CVD system, not only this but this invention is applicable to the process unit at large which is made to generate the plasma and performs etching and cleaning. For example, it is applicable to the membrane formation equipment of silicon oxide, a silicon nitride, the polish recon film, the tungsten silicide film, the aluminum film, and the tungsten film, or the plasma etching system of these film.

[0030] Gestalt 2. drawing 3 of operation is drawing showing the semiconductor fabrication machines and equipment by the gestalt 2 of implementation of this invention, and shows other examples which applied this invention to the CVD system. In drawing A wafer 1, a susceptor 2, the shadow ring 3, the membrane formation chamber 4, a spare room 5, the wafer carrier-robot arm 6, the porous nozzle head 7, a gas supply system 8, the wafer cassette 9, a lamp 10, the lamp window 11, an exhaust pipe 12, the end point detector 13, an aperture 14, Since the particle monitor 15, laser radiation system 15a, detector 15b, Apertures 15c and 15d, the slit bulb 16, and the terminal point detection control unit 31 are the same as the equipment of the gestalt 1 of the above-mentioned implementation shown in drawing 1 , the explanation is omitted.

[0031] In addition to the equipment shown in drawing 1 , the tungsten CVD system concerning the gestalt 2 of this operation forms a latching valve 17 in an exhaust pipe 12. This latching valve 17 is formed between the membrane formation chamber 4 and the particle monitor 15, and it acts so that vacuum separation of the membrane formation chamber 4 and the particle monitor 15 may be carried out. Since the valve of the structure which does not bar passing of the minute particle which flies the inside of an exhaust pipe 12 from the membrane formation chamber 4 as a latching

valve 17 is desirable, a gate valve and a ball valve are used, for example.

[0032] Next, actuation is explained. Although the apertures 15c and 15d of the particle monitor 15 cannot bloom cloudy easily, in order to maintain equipment at the optimal condition, it is necessary to clean these apertures 15c and 15d periodically. By closing a latching valve 17, cleaning of the apertures 15c and 15d of the particle monitor 15 is performed, where it separated the membrane formation chamber 4 and the particle monitor 15 and the membrane formation chamber 4 is maintained at a vacuum. Thereby, since it is not exposed to atmospheric air, after cleaning of the apertures 15c and 15d of the particle monitor 15 is completed, the inside of the membrane formation chamber 4 can resume a latching valve 17, and can continue membrane formation processing of a tungsten promptly. Moreover, in case it maintains by carrying out atmospheric-air disconnection of the membrane formation chamber 4, when there is little apertures [of the particle monitor 15 / 15c and 15d] dirt, a latching valve 17 is closed and evacuation of the particle monitor 15 is carried out. By this actuation, since oxidization of an Apertures [15c and 15d] affix can be controlled, it is not necessary to clean the apertures 15c and 15d of the particle monitor 15 at the time of the maintenance of the membrane formation chamber 4.

[0033] As mentioned above, according to the gestalt 2 of this operation, since the latching valve 17 was formed between the membrane formation chamber 4 and the particle monitor 15, it becomes possible to maintain the inside of the membrane formation chamber 4 at a vacuum during the maintenance of the particle monitor 15. Since it becomes possible to, start the equipment after maintenance termination immediately as a result, decline in the operating ratio of the equipment accompanying the maintenance of the particle monitor 15 can be stopped to the minimum. Moreover, since the cleaning frequency of equipment can be made low, the operating ratio of equipment can be raised.

[0034] Gestalt 3. <u>drawing 4</u> of operation is the fracture perspective view of the principal part of the CVD system by the gestalt 3 of implementation of this invention, and is set to drawing. 1 -- a wafer and 2 -- for a membrane formation chamber and 6, although an exhaust pipe, and 15 and 18 are particle monitors, a susceptor and 3 a shadow ring and 4 [a wafer carrier-robot arm and 11] [a lamp window, and 12a and 12b]

Since these components are the same as the thing of the equipment concerning the gestalt 1 of the above-mentioned implementation shown in drawing 1 , detailed explanation is omitted.
[0035] The CVD system concerning the gestalt 3 of this operation forms two or more exhaust pipes 12a and 12b in the membrane formation chamber 4, and forms the particle monitors 15 and 18 in each exhaust pipes 12a and 12b. Drawing 4 forms two exhaust pipes 12a and 12b in the membrane formation chamber 4, and shows the example which formed the particle monitors 15 and 18 to each exhaust pipes 12a and 12b. Furthermore, the CVD system concerning the gestalt 3 of this operation is equipped with the signal processor 21 which computes the location which the particle monitors 15 and 18 processed the raising dust signal which outputs the value which counted the minute particle number, and the raising dust in the membrane formation chamber 4 generated.
[0036] Next, actuation is explained. If a location gap arises in case a wafer 1 is laid on a susceptor 2 using the wafer carrier-robot arm 6, when raising a susceptor 2 after that and putting the shadow ring 3 on a wafer 1, a wafer 1 and the shadow ring 3 will wear and carry out raising dust. The minute particle which this generates rides the flow of process gas, and is exhausted. Since the rate of flow of process gas is fixed, if it sets to v the flying speed of the minute particle mentioned above, it can be considered that v is almost fixed. Time amount t1 to which the minute particle which a wafer 1 and the shadow ring 3 wear for which and generate at the time of the rise of a susceptor 2 flies even to two particle monitors 15 and 18 And t2 It can ask to be shown in drawing 5 on the basis of the rise time of day of a susceptor 2.
[0037] The detecting signal (a) of the particle monitor 15 shown in drawing 5 and the detecting signal (b) of the particle monitor 18 are outputted to a signal processor 21. The signal processor 21 into which a detecting signal (a) and (b) were inputted pinpoints a raising dust source location by computing the intersection K with the circle C18 of radius t2 v centering on the installation location of the particle monitor 15 centering on the circle C15 of radius t1 v, and the installation location of the particle monitor 18, as shown in drawing 6 . If the location K which raising dust generates is pinpointed, the control section (not shown) of equipment will amend the location where the wafer carrier-robot arm 6 delivers a wafer 1

so that the raising dust of the ** of a wafer 1 and the shadow ring 3 to exceed may not be canceled and carried out. Since a series of raising dust dissolution actuation mentioned above can be performed without breaking the vacuum of the membrane formation chamber 4, it can raise the operating ratio of equipment.

[0038] As mentioned above, according to the gestalt 3 of this operation, two or more particle monitors 15 and 18 and signal processors 21 are used. When [sudden at the time of wafer 1 delivery] it rubs and raising dust occurs, a raising dust location is pinpointed from the difference in the raising dust detection time which each particle monitors 15 and 18 detect. Since it enabled it to cancel without breaking the vacuum of the membrane formation chamber 4 for ** accompanying delivery of a wafer 1 to exceed based on it, the operating ratio of equipment can be improved sharply.

[0039] Gestalt 4. drawing 7 of operation is drawing showing the raising dust evaluation equipment by the gestalt 4 of implementation of this invention, and is set to drawing. The raising dust evaluation equipment which 100 requires for this invention, the stainless plate which has the magnetism to which 101 performed blasting processing using abrasive (member which has magnetism), For the susceptor (member deformation means) which supports the stainless plate 101 with which 102 has magnetism in the shape of a cantilever, and 103, as for a permanent magnet and 105, an electromagnet (member deformation means) and 104 are [residual abrasive and 106] stainless steel powder. In case the raising dust evaluation equipment concerning the gestalt 4 of this operation proofreads detection precision of a particle monitor, it is used as a generation source of the minute particle which the particle monitor 15 detects.

[0040] Next, actuation is explained. If a current is intermittently passed from a power source (not shown) on the electromagnet 103 formed in the raising dust evaluation equipment 100 concerning this invention shown in drawing 7 , magnetism will occur intermittently. If the free end of the stainless plate 101 which has the magnetism supported by this magnetism in the shape of a cantilever is made to attract and repel and is made to deform, the residual abrasive 105 will be emitted from the front face of the stainless plate 101 which has magnetism. The particle size of this residual abrasive 105 is prescribed by the particle size of the abrasive used for

blasting processing. As residual abrasive 105, particle size uses what is within the limits of 1 to 20 micrometers in general. Therefore, the particle size of the residual abrasive 105 emitted from the front face of the stainless plate 101 which has magnetism will become almost uniform in general with the value within the limits of 1 to 20 micrometers. On the other hand, since the stainless steel powder 106 emitted to coincidence does not have homogeneity in particle size, it has removed by making it stick to a permanent magnet 104.

[0041] In the raising dust evaluation equipment 100 concerning this invention shown in drawing 7 , it installs in the membrane formation chamber 4 of the semiconductor fabrication machines and equipment concerning the gestalt 1 of operation shown in drawing 1 , and if the pulse current of normal frequency is impressed to an electromagnet 103, convention number emission of the residual abrasive 105 with a uniform particle size will be carried out into unit time amount from stainless plate 101 front face which has magnetism. Since the particle monitor 15 is passed when such residual abrasive 105 is discharged out of equipment through the inside of an exhaust pipe 12, the particle monitor 15 counts the number of the residual abrasive 105 which passes in unit time amount. The detection precision of the particle monitor 15 is proofread by adjusting sensibility so that the counted value may be restored to convention within the limits.

[0042] as mentioned above -- since it can operate in a vacuum or low-pressure process gas according to the gestalt 4 of this operation -- the bottom of an actual operating environment -- and since the particle of a particle size predetermined to the timing of arbitration can be generated, it becomes possible to proofread detection precision of the particle monitor 15 in a high precision.

[0043] In addition, although the gestalt 4 of the above-mentioned implementation showed the example using stainless steel as a member which performs blasting processing from viewpoints, such as corrosion resistance over corrosion prevention and process gas, even if it uses other corrosion resistance high magnetic materials, for example, a ferrite etc., there is same effectiveness.

[0044] Although the flying speed v of a minute particle was constituted from a gestalt 3 of the gestalt 5. above-mentioned implementation of

operation as equivalent to the rate of flow of process gas, it is generated also when the flying speed v of a minute particle differs from the rate of flow of process gas depending on the configuration of the membrane formation chamber 4, or the particle size of a minute particle. In this case, install the raising dust evaluation equipment 100 concerning this invention that showed two or more particle monitors 15 to drawing 7 in the semiconductor fabrication machines and equipment attached in the membrane formation chamber 4 in the location corresponding to the inner circumference top of the location 3 which it rubs and raising dust tends to generate, for example, a shadow ring, it is made to operate in pulse, and the flying speed v of a minute particle is amended by observing a generating particle with two or more particle monitors 15. The precision which pinpoints the generating location of the raising dust which this generates suddenly can be raised.

[0045]

[Effect of the Invention] Plasma etching [according to invention according to claim 1] in an etching system, Or the particle number which the particle monitor which established the terminal point of the plasma cleaning in membrane formation equipment in the exhaust pipe which exhausts the gas in a process chamber generates at the time of plasma etching or plasma cleaning is measured. Since it constituted so that a terminal point detection control unit might observe and detect this measurement value by time series While becoming possible to be stabilized over a long period of time and to detect the end point of plasma cleaning and being able to lengthen the maintenance period of equipment, there is effectiveness which raises the operating ratio of equipment.

[0046] According to invention according to claim 2, it becomes possible to maintain the inside of a process chamber at it during the maintenance of a particle monitor at a vacuum, since it constituted in the exhaust pipe between a process chamber and a particle monitor so that the latching valve which intercepts between these process chamber and particle monitors might be prepared. Since it becomes possible to, start the equipment after maintenance termination immediately as a result, there is effectiveness which can stop decline in the operating ratio of the equipment accompanying the maintenance of a particle monitor to the minimum.

[0047] Since according to invention according to claim 3 it constituted as a latching valve so that a gate valve or a ball valve might be used, there is effectiveness which does not bar the flight of the minute particle from a process chamber.
[0048] According to invention according to claim 4, two or more exhaust pipes are formed in a process chamber. Since it constituted so that it might have the signal processor which installs a particle monitor in each exhaust pipe, and computes a raising dust location based on the raising dust time-of-day detecting signal from two or more of these particle monitors Since it constituted so that a raising dust location might be pinpointed from the difference in the raising dust detection time which two or more particle monitors detect when [which was sudden at the time of wafer delivery] it rubbed and raising dust occurred In ** accompanying wafer delivery based on the specific result of a raising dust location to exceed, since the vacuum of a process chamber can be canceled without breaking, it is effective in the operating ratio of equipment improving sharply.
[0049] Since according to invention according to claim 5 it constituted so that it might have the member which has the magnetism which carried out blasting processing of the front face using the abrasive of a predetermined particle size, and the member deformation means to which this member is made to deform into and residual abrasive is made to emit, since this raising dust evaluation equipment can operate in a vacuum or low-pressure process gas, it is under a real operating environment, and it can generate the particle of a particle size predetermined to the timing of arbitration. Therefore, there is effectiveness which can proofread detection precision of a particle monitor in a high precision.
[0050] Since according to invention according to claim 6 it constituted so that it might have the susceptor which supports the stainless plate which uses stainless steel for the ingredient of the member which has the magnetism which carried out blasting processing of the front face, and has magnetism for a member deformation means in the shape of a cantilever, and the electromagnet the free end of a stainless plate is made [electromagnet] to attract and repel [electromagnet], it is effective in the high raising dust evaluation equipment of practicality being realizable with a simple configuration.

[0051] According to invention according to claim 7, in the process chamber of the semiconductor fabrication machines and equipment concerning invention given [of claim 1 to the claims 4] in any 1 term At least one raising dust evaluation equipment concerning invention according to claim 5 or 6 is installed. Since it constituted so that the flying speed of a particle might be proofread by operating this raising dust evaluation equipment in a vacuum or a predetermined process gas ambient atmosphere, generating many particles, and detecting these particles with a particle monitor When the flying speed of a minute particle differs from the rate of flow of process gas, Since the flying speed of a minute particle can be amended by observing the particle which installs raising dust evaluation equipment in the location corresponding to the location which it rubs and raising dust tends to generate, is operated in pulse, and is generated with two or more particle monitors It is effective in raising the precision which pinpoints the generating location of the raising dust generated suddenly.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the semiconductor fabrication machines and equipment by the gestalt 1 of implementation of this invention, and the example which applied this invention to the CVD system is shown.

[Drawing 2] It is the graphical representation showing the example of observation of the number of counts of the minute particle which used and measured the particle monitor 15 at the time of plasma cleaning.

[Drawing 3] It is a semiconductor-fabrication-machines-and-equipment **** Fig. by the gestalt 2 of implementation of this invention, and other examples which applied this invention to the CVD system are shown.

[Drawing 4] It is the fracture perspective view of the principal part of the CVD system by the gestalt 3 of implementation of this invention.

[Drawing 5] It is drawing showing the detecting signal (a) of the particle monitor 15, and the detecting signal (b) of the particle monitor 18.

[Drawing 6] It is drawing showing the example which computes the intersection K with the circle C18 of radius t2 v centering on the installation location of the particle monitor 15 centering on the circle C15 of radius t1 v, and the installation location of the particle monitor 18.
[Drawing 7] It is drawing showing the structure of the raising dust evaluation equipment by the gestalt 4 of implementation of this invention.
[Drawing 8] It is the cross-section block diagram showing the conventional tungsten CVD system typically.
[Description of Notations]
1 A wafer, 4 A membrane formation chamber (process chamber), 12 An exhaust pipe, 15 particle monitor, 17 A latching valve, 21 A signal processor, 31 A terminal point detection control unit, 101 The stainless plate (member which has magnetism), 102 which have magnetism Susceptor (member deformation means), 103 Electromagnet (member deformation means).

[Translation done.]